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FURTHER EDUCATION IN THE WELFARE STATE

IN his recent book, "The English Universities and Adult Education" (see *Nature*, November 17, p. 887), Mr. S. G. Raybould takes up first the challenge that the work of the extra-mural departments of the universities of Great Britain should justify its support primarily in terms of the nature of university work, and not on grounds of the value of adult education in general. Accordingly, his first chapter examines the question of university standards. Indeed, he regrets that the challenge has not been presented earlier in a form compelling a reply ; but his challenge should certainly stimulate that fresh thought about the nature and purpose of adult education, in relation both to the development of the individual and to social change, which is an urgent need. If at the same time there is further fundamental thinking about the purposes and functions of a university, there should be little danger that any attempt to instil the spirit and method of university teaching into all adult education will fail to meet the essential test which should be applied to any increase in university commitments. This, as Mr. Raybould rightly insists, is not whether educational needs exist which are not being met, but whether they are of a character proper for universities to meet.

In his examination of this question of standards and of the possibility of adult part-time students attaining a university standard, Mr. Raybould emphasizes one argument for university participation in adult education which has gained much force since it was considered by the Oxford report of 1909 entitled "Oxford and Working-class Education", and that of the Ministry of Reconstruction in 1919. Both reports recognized adult education as a means by which the universities can play a part in equipping men and women in all walks of life for discharging effectively their responsibilities as members of a democratic community. Subsequent political developments have strengthened this argument. As Mr. Sydney Ball remarked in a paper at the Workers' Educational Association Conference at Oxford last year : "Changes in the structure of English Society are throwing more and more responsibility on the shoulders of men who have had no opportunity of obtaining the synoptic mind which, as Plato says, is desirable in governors".

Nor is this all. Mr. Raybould himself adds that the increasing complexity of industrial organization, and the growing tendency of different classes to live in different quarters of the same town, or even in different towns, make it increasingly difficult for the various sections of the community to appreciate each others' circumstances and aspirations. That reason alone would make it important for leaders of every class to have an opportunity of obtaining a wide outlook on the historical development and economic condition of the whole English community, such as can be given by a university education. This point of view was strongly endorsed in the paper on "Some Aspects of Technical Education in the United States

and Great Britain" which Dr. P. F. R. Venables delivered at the British Association meeting last August. Noting that the emphasis placed in the United States on general education and social studies in the curricula for courses for technological degrees is primarily on professional grounds, he suggested that this aspect of technological education deserves more attention in Great Britain than it has received. Even for part-time degrees and 'higher national certificates', he suggested that experiment is required in the provision of such post-advanced courses, especially by university extra-mural departments, and that such part-time postgraduate courses would have the advantage of being given to older students with industrial experience of potential significance.

The value of that argument is fully admitted by Mr. Raybould in discussing the question of standards; but Dr. Venables advances a further reason which, particularly at the present time, should ensure that the claims of adult education on the universities receive careful evaluation. Dr. Venables expresses the view that the courses in engineering and business administration described in the United States as 'social technology' have completely justified themselves, both as regards the students and also as regards industry, which because of its increasing complexity and its social problems needs men who are trained to handle people as well as to initiate and develop processes. He suggests that we would do well to examine the possibility of making similar provision in Great Britain, and not least in relation to productivity problems.

Any such examination must at present take account of what is being done both in the universities and in the technical colleges, and emphasizes the undesirability of dealing with technological education and university education in isolation, either from one another or from adult education in general. Mr. Raybould urges almost as strongly as Dr. Venables that not only are industrial relations an important subject of study in universities as well as elsewhere, but also that, because of the concern of such study with ends as well as means, it is particularly appropriate for association with adult education, when theory can illuminate—and itself be illuminated by—practice. Such subjects as international relations and industrial relations are, he suggests, more effectively developed as adult than as undergraduate studies, and in no other subject is there greater need for the characteristic methods and virtues of the university—thoroughness, candour and tolerance.

Persuasively though Mr. Raybould presents these important arguments for university participation in adult education, he does not disguise the test of such participation which he himself suggests. He contends that whatever the subjects studied, the attainment of a 'university standard' of work in extra-mural classes normally demands a long and systematic course of study. Given this and the conditions implied, but not otherwise, Mr. Raybould maintains that adults may, in part-time courses, undertake work and achieve results which justify universities in providing the teaching, particularly in the humanities and in those studies needed for the effective discharge of the responsibilities of citizenship. Since 1945, however, university extra mural agencies have provided a much larger number and proportion of short courses not involving "serious student effort" than at any time before that date. The expectation that the short courses would lead to longer and more systematic courses has not in general been realized. Accordingly, Mr. Raybould suggests that a radical change of policy in extra-mural work is required, with a shifting of emphasis from quantity to quality. First, he would omit most of the short courses which do not involve, in addition to attendance at lectures and discussions, directed study on the part of the students, apart from such courses, such as refresher courses designed to keep graduates engaged in teaching, industry or professional work in touch with current research in their special subjects. In most universities this policy would involve a scaling-down of programmes of work and the transfer of responsibility for elementary courses to other bodies such as the Workers' Educational Association.

Mr. Raybould recognizes clearly what is implied by such a policy, and the modifications in organization, the staffing of extra-mural work and financial arrangements which are involved. These are discussed in successive chapters in which criticisms already advanced of university participation in this work are considered in relation to particular points. All his experience does not make Mr. Raybould dogmatic; but he is confident that the difficulties can be overcome and is convinced that here is work which the universities should undertake, but with deeper insight and a fuller sense of responsibility, and with something of the spiritual impulse which inspired the whole movement thirty or forty years ago. Only then are the universities likely to avoid the danger of dissipation of their resources.

There can be no question that constructive and imaginative thinking is required, no less on the part of the universities than of the Workers' Educational Association itself. To the future policy of that Association Mr. Raybould directed attention in his booklet "The W.E.A.—the Next Phase", published two years ago. The questions there discussed are raised again in his book, and in a wider context, which makes it clear that the right answers can only be found when the functions of the universities and the broad educational situation of Great Britain are taken into account. The vital need is for fresh thought about the nature and purpose of adult education.

'OPOSSUM SHRIMPS'

The British Mysidacea

By the late Prof. W. M. Tattersall and Olive S. Tattersall. (Ray Society, Vol. 136, for the Year 1950.) Pp. viii+460. (London: Bernard Quaritch, Ltd., 1951.) 42*s*.

WHEN Prof. W. M. Tattersall died in 1943, he had been collecting materials for a monograph on the British Mysidacean Crustacea which was to be published by the Ray Society. In this work he had been assisted by Mrs. Tattersall, herself a competent zoologist, who had prepared a

considerable number of the illustrations. Most of the voluminous material, however, was in the form of notes, lists of localities and so forth, and only a few pages were actually ready for the printer. Mrs. Tattersall resolved to undertake the heavy labour of completing the monograph, incorporating her husband's notes and preparing the rest of the drawings. It may be said at once that she has accomplished admirably her self-imposed task, and that the many friends of her late husband will be grateful to her for having provided this worthy memorial to him.

The book opens with a historical summary of the literature on the group, followed by chapters on the general morphology and bionomics. These chapters are quite competently done, although Prof. Tattersall's great experience would, no doubt, have enabled him to supplement them on many points. It would have been interesting, for example, to have had a fuller discussion of the so-called 'luminous organ', from which the genus *Gnathophausia* derives its name. In the systematic part which follows, the keys to families, genera and species seem to be well constructed, although their adequacy could only be tested by using them in the actual determination of specimens. The generic and specific diagnoses are clearly phrased and so arranged that comparison is easy. The figures are admirably clear and, from an artistic point of view, are not unworthy to be placed alongside the work of such masters of crustacean iconography as G. O. Sars and H. J. Hansen.

A valuable feature of the book is the list of localities in British seas given for each species. These lists are taken from Prof. Tattersall's notes, and, in very many cases, were authenticated by his own examination of specimens. Where this could not be done, the names of the authors responsible for the records are given. As in the case of many other groups of marine invertebrates, these lists show how patchy is our knowledge of the distribution of the littoral fauna around British shores. Very few marine laboratories have published lists of the local fauna like that available for Plymouth, and over great stretches of coastline where there are no laboratories the composition of the littoral fauna is a subject for guesswork. For example, there is some reason for believing that the fauna of the shores of the Moray Firth differs considerably from that of the rest of East Scotland; but there are very few Mysidacea recorded from it in this work.

A good deal of importance is attached to Geoffrey Smith's supposed discovery of a vestigial exopod on the mandible of *Paranaspides* (which is not, of course, a Mysidacean, as the unwary reader of p. 10 might be led to suppose). It is necessary, therefore, to say that no one has been able to confirm Smith's statements on this point and that the 'exopod' was certainly absent in the single specimen dissected by the present writer in order to search for it.

Misprints and similar errors, although not numerous, are sufficiently conspicuous to suggest inadequate proof-reading, for which, of course, the author may not be to blame: "neutral" for "neural" makes nonsense on p. 360; Davis Straits is not in Scotland (p. 119), nor St. Andrews in the "north" of that country (p. 372); the maxilla is not a "thoracic" appendage (p. 300); and a very distinguished British zoologist of the last generation (or the one before that, perhaps) did not spell his name "Lancaster" (p. 433). Finally, several references in the text are not explained in the bibliography at the end of the volume.

W. T. CALMAN

NATURAL HISTORY OF GUANOS

Survey of Existing Knowledge of Biogeochemistry, 3
The Biogeochemistry of Vertebrate Excretion. By George Evelyn Hutchinson. (Bulletin of the American Museum of Natural History, Vol. 96.) Pp. xviii+554+16 plates. (New York: American Museum of Natural History, 1950.) 10 dollars.

GUANO has played a considerable part in agricultural history. The original Peruvian material began to be imported into Great Britain, in substantial amount, during the 'hungry forties' of the nineteenth century, and for more than a generation it constituted a substantial part of the total fertilizer supply. In the southern part of the United States, also, it restored the productivity of the worn-out soils of the old tobacco and cotton plantations. We now know that its effects are to be explained simply enough—it provided both phosphate and nitrogen in concentrated and readily available forms. But farmers often thought of it as something with quite miraculous properties.

Mr. G. E. Hutchinson's monograph is by far the most complete treatise on the subject, and the standard of his scientific scholarship is of the highest. He enumerates and describes the known deposits, analyses the climatological and biological conditions under which they have been formed, critically examines the great mass of literature and points to the lack of proof for some of the earlier theories and to the remaining gaps in our knowledge.

Many of the broad generalizations about guano formation are easily to be understood. Large volumes of excrement and egesta will be deposited wherever large numbers of sizable animals congregate to rest or to rear their young. Marine birds and seals yield the largest quantities of possible raw material; and in both cases a fish diet results in material with high initial contents of phosphates and of nitrogen compounds. But, other things being equal, the product from birds will have the higher value, because the excreted nitrogen is mostly in the relatively stable form of uric acid and, moreover, is in a semi-solid form that is rapidly desiccated. Preservation is tolerably complete only on rainless sites, because even moderate and occasional moistening leads to a breakdown of nitrogen compounds into volatile products. Again, the eggs and young of sea-birds are liable to wholesale destruction by land predators, so that island sites are the only ones that can support large permanent bird-colonies; certain rainless islands, however, are uncolonized because soil or rock surfaces reach day temperatures that are lethal to developing embryos.

In many cases the population of guano birds shows marked cyclical changes—usually a gradual build-up followed by holocaust. The latter does not seem to result from a build-up either of birds of prey or of parasites, and famine rather than epidemic disease seems to be the common cause. The catastrophic falls are more marked among surface-feeders than among deep-diving species, and may thus probably be related to changes in the size and frequency of shoals of shallow-swimming fish. Where the chief food of a particular surface-feeding bird is a species of fish that swims at depths which vary according to the relative temperatures of the upper and lower waters, the immediate cause of catastrophe might be, for example, a persistent high temperature of the uppermost layer of the sea. It is thus tempting to

believe that the ultimate cause of the bird's population cycle is to be sought in a regular cyclical change in ocean currents. But catastrophes do not seem to occur with the degree of regularity that would be expected on such a hypothesis.

Mr. Hutchinson's study will be of great interest to students of animal population.

J. A. Scott Watson

THE GORILLA

The Anatomy of the Gorilla

The Studies of Henry Cushier Raven, and Contributions by William B. Atkinson, Herbert Elftman, John Eric Hill, Adolph H. Schultz, William L. Straus, Jr., and S. L. Washburn. Arranged and edited by William King Gregory. (The Henry Cushier Raven Memorial Volume: a Collaborative Work of the American Museum of Natural History and Columbia University.) Pp. viii+259 (116 plates). (New York: Columbia University Press; London: Oxford University Press, 1950.) 97*s*. 6*d*. net.

At the time of his death in 1944, Henry Raven was curator of the Department of Comparative Anatomy of the American Museum of Natural History. He had been a naturalist from boyhood and had visited many parts of the world in search of birds and mammals for the American Museum. In 1929 he returned from an expedition to Africa with a collection of 'pickled' gorillas and also a young live chimpanzee, which soon became a celebrated character in New York. She lived in the Raven house, and took part in a number of Raven's public lectures on anthropoid life. From this time on, his interests became increasingly fixed on the primates, and during the ensuing years he devoted much time to the anatomical study of the gorillas which he had brought back from the jungles of the Belgian Congo and the Cameroons. His death occurred before the completion of his task, and the present volume is a record of his own descriptions of the muscles, blood vessels, peripheral nerves and reproductive organs, supplemented by notes provided by the late J. E. Hill. Raven was primarily interested in regional anatomy, and his descriptions do not attempt to correlate form with function, nor to compare the anatomy of the gorilla with that of man and other primate types. The volume has been rounded-off with short contributions on the thoracic viscera, by S. L. Washburn; on the abdominal viscera and female reproductive system, by H. Elftman and W. B. Atkinson; on the skin, by W. L. Straus; and on the skull, teeth, palatine ridges and growth, by A. H. Schultz.

Raven's detailed descriptions of the musculature of the gorilla are accompanied by a magnificent series of plates and line drawings, many of which were prepared under his personal supervision. Partly, however, because of his premature death, the balance of his section of the volume is uneven. Thus, in contrast to the detail with which he treats the muscles, he devotes only a few pages to the vascular and reproductive systems. The osteology of the gorilla—a subject of great importance in the study of primate fossils—is dealt with scarcely at all. This lack of balance is unfortunately not corrected by the supplementary chapters in the book which, while they also provide excellent and much-needed information, again deal only with limited aspects of the subject.

Dr. W. K. Gregory points out in a foreword that Raven began his dissections of the gorilla with the object of providing a "comprehensive anatomy of this great near relative of man". There can be no doubt that, while he was prevented from doing this, he has nevertheless left what the fly-leaf calls a "permanent definitive work in this field". In the chapter which he has provided, Prof. Schultz remarks that "the literature on gorillas contains many premature generalisations supported by far too few observations". In as highly variable an animal as the gorilla, he goes on to say, "large series of specimens must be investigated in order to establish really representative averages and to find the full ranges of individual variations". The anatomy of the great apes has never been studied, as he indicates, on a scale commensurate with the prominent position these animals occupy in discussions on human evolution. The Raven Memorial Volume helps to show how small is the area of anatomical fact on which these evolutionary discussions are based, and how much needs to be done to strengthen the factual foundation on which has been built so large and detailed a superstructure of phylogenetic speculation.

NEO-VITALISM AND FARMING

Food, Farming and the Future

By Friend Sykes. Pp. 294. (London: Faber and Faber, Ltd., 1951.) 21*s*. net.

Of late years there has been a revival in certain agricultural circles of the old vitalistic ideas formerly widely held until Wöhler's synthesis of urea broke down the distinction between substances which could be prepared in the laboratory and those which could not, but required the intervention of a living organism. Broadly speaking, the position of their successors to-day is that the nutrient salts considered by modern plant physiologists as necessary and sufficient for the full growth of plants are in reality not so, but they need in addition some vital principle which has hitherto eluded chemists and physiologists. In addition to the well-recognized continuity of life through the seed, there is another continuity through the nutrients, and unless these have recently formed part of some living organism the plant, though morphologically complete, lacks some essential quality; in particular, it becomes susceptible to disease, and if fed to animals or human beings induces a like susceptibility in them.

The idea was put forward by the late Sir Albert Howard, and its element of mysticism and supposed naturalness at once made an appeal; it was taken up by a group of able and persuasive advocates of whom Mr. Friend Sykes, the author of the present volume, is one of the best known. He has already written "Humus and the Farmer" and had not intended producing another book on the subject; but his correspondence showed that further clarification was necessary, and this he has set out to effect.

Mr. Sykes's farming system consists in growing a four-year ley which, as in the Clifton Park system, includes some deep-rooting plants, and then ploughing up and growing cereals for four years. The straw is converted into farmyard manure in the old-fashioned way by wintering cattle in stock yards, and the manure thus produced is given to the potatoes,

kale and other crops. There are no special features here; similar systems can be found elsewhere.

The difference from ordinary farming is that Mr. Sykes uses no fertilizers and no chemical agents for plant or animal protection. By withholding fertilizers he claims that his crops are entirely free from disease and produce seed free from adherent fungus spores, so that no seed dressing is ever required; that his animals likewise suffer neither disease nor sterility; and further, that his cereals have a health-giving quality lacking in ordinary farm produce. He recognizes that the basis of his crop production is the nitrogen of the air as in ordinary farming, but he maintains that the plant nutrient produced by microbiological fixation has far greater value than that produced by catalytic fixation; the end-product is nitrate, but in one case the nitrate is natural and associated with the vital principle, and in the other it is artificial and devitalized.

Unfortunately, the evidence for the claim is entirely subjective. Mr. Sykes claims to be able to detect by taste the difference between humus-grown crops and those produced in the usual way. An experiment on the farm scale has been set up; it will be convincing only if both design and execution conform to modern standards. In these days of hormones, trace elements and isotopes, no responsible scientific worker would pretend that the full story of plant nutrition is yet known; but standards of experimental technique have advanced greatly in recent years, thanks largely to the Rothamsted workers, and experiments can be designed in such a way that the validity of the results can be tested. Only when satisfactory evidence can be adduced are the theories of the author's group likely to be accepted. E. John Russell

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LEEUWENHOEK

Antoni van Leeuwenhoek

Zijn Leven en zijn Werken. Door Dr. A. Schierbeek. Deel 1. Pp. 278+18 plates. 10 f. Deel 2. Pp. 281–526+10 plates. 12 f.
(Lochem: 'De Tijdstroom', 1950–51.)

THE literature that has rapidly grown up around Leeuwenhoek since the publication of Dobell's classic work in 1932 would suggest the preparation of a general treatise devoted to his scientific researches as a whole. Dobell's study, admirable as it is, covers only a small fraction of the work of the celebrated Hollander. Out of a projected total of twenty volumes of the "Opera Omnia" the Leeuwenhoek Commission of Amsterdam has so far produced only three volumes since 1939, and the War has well-nigh shelved this sumptuous and costly enterprise. If, however, as we all hope, it can be completed on the scale of the detailed magnificence of the early volumes, we shall have a monument to Leeuwenhoek worthy of the man and of the Dutch nation. The recently instituted Leeuwenhoek lecture by the Royal Society is not intended to deal with Leeuwenhoek's own work, but rather with *modern* developments in microbiology—a branch of science in which Leeuwenhoek's discoveries have earned for him the title of 'Father'.

Dr. A. Schierbeek's book, therefore, comes at a time when an inclusive and critical examination of Leeuwenhoek's researches based on a thorough knowledge of all the original letters in Dutch, and also on the labours of modern commentators, might reasonably have been expected. It is true that such an author would find his own knowledge of biology severely tested, and, moreover, several minor researches of his own would be necessary before a final judgment could be reached on those points which always emerge during the progress of such a work. Dr. Schierbeek's professional duties are sufficiently exacting to tax both energy and endurance, and he is to be congratulated on the production of a learned work which must have entailed considerable literary and objective research. Its wide scope and complexity is indicated by the following translation of the chapter and sectional headings, outlining Leeuwenhoek's personality and researches, into which the text is divided. Vol. 1. (1) Life and works. The first forty years. As a citizen, an usher in the council chamber, a wine gauger, surveyor, and an amateur scientific worker. His mentality and psychological type. (2) His microscopes and research methods. (3) His attitude towards inorganic Nature and concern with mathematics, physics, chemistry and geology. (4) As the father of microbiology. On free-living and parasitic unicellular animals, rotifers, phytoflagellates, soil micro-organisms, seaweeds, mildew, bacteria and yeast. (5) On the study of the lower animals, such as stinging animals (Cœlenterates), sponges, molluscs, worms, spiders, and the higher Crustacea. (6) As an entomologist. On the anatomy of advantageous instincts, compound eye, galls and gall insects, clothes [body] louse, flea, grain weevil and its treatment, aphis, parthenogenesis and ichneumon parasites. The first volume closes with a genealogical table of the Leeuwenhoek family.

Vol. 2. (7) On the investigation of the vertebrate animals. (8) Discovery of the spermatozoa and views on generation. (9) As an histologist. On the structure of muscle, blood corpuscles and blood vessels, digestion and microscopic structure of gut, bone, teeth, skin, sweat glands, hair, nails, structure of nerves, brain and spinal cord, lens of eye, tongue, saliva, nasal mucus, phlegm, ear, kidney, bile production, milk, fat, ciliated epithelium, chromatophores, and nuclei. (10) Medical observations. (11) On botany. Structure of wood, structure of monocotyledons, tyloses, vessels, vacuolated tissue, raphides, starch, movements of sap, fruit and seed, growth of meristem in wheat ear, laticiferous vessels, stinging hairs, hairs of Labiatæ, and plants used in medicine. (12) As ecologist. (13) Summary and appendixes. The published letters and bibliography of Dutch and Latin editions. The relevant literature.

Dr. Schierbeek surveys this comprehensive and bewildering field with the confidence of an enthusiast steeped in his subject, and, as a Dutchman, better able to unravel Leeuwenhoek's many puzzling and involved passages, often made less intelligible by his use of obsolete colloquialisms. I regret the mistake of publishing so important a work in a language unfamiliar to the larger foreign public attracted by the subject. Perhaps Dr. Schierbeek will now prepare an English translation, for which a publisher could readily be found in Britain, if not in Holland. In framing the idiom of the Dutch text of his work, I fear that Dr. Schierbeek has not always borne in mind that the affairs and work of Leeuwenhoek interest a widening non-Batavian circle.

[Since the above notice was written, Dr. Schierbeek has been approached by an American publisher with an offer for the publication of an English translation of his memoir.] F. J. Cole

The Middle East

A Physical, Social and Regional Geography. By Dr. W. B. Fisher. Pp. xiii+514. (London: Methuen and Co., Ltd.; New York: E. P. Dutton and Co., Inc., 1950.) 27*s*. 6*d*. net.

THE first problem with which Dr. W. B. Fisher had to contend was the definition of the Middle East, a term that is used in widely varying senses. He regards as a unit the area east from Cyrenaica, Crete and Egypt to Arabia and Iran and north to Turkey. No other part of Africa is included. His use of the term leaves no room for the cognate one of Near East, which is generally applied to the eastern end of the Mediterranean. But, after all, this is only a matter of nomenclature and does not affect the value of the book. The physical background outlined by Dr. Fisher is relatively slight but adequate, and his treatment of the climate and vegetation is specially good. But interest on the whole is concentrated on the social, economic and historical aspects. The book is readable and none too long for the vast scope of its subject. In places it is unduly brief, for example, on the Suez Canal in both its physical and political aspects and perhaps also on Egypt. There are many sketch maps, some a little crude, and adequate bibliographies. R. N. R. B.

Land Utilization in Australia

By Prof. C. M. Wadham and Prof. G. L. Wood. Second edition, revised. Pp. xx+376+77 plates. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1950.) 30*s*. net.

THIS post-war revision of a valuable study will be read with interest by those concerned with the land resources of the world and their utilization. The special interest of this edition is twofold. There is a consideration of the impact of war-time production and trade in the Australian Continent and the influence of such factors as the closing of markets, new needs, such as the British demand for flax, and even the American soldier's non-acceptance of mutton. Then there is the assessment of the question of post-war development and the discussion of settlement possibilities, always a matter of interest so far as Australia is concerned. Here the exposition of the deterrents to any close settlement of even the more favoured regions is of particular note and should be studied by those who tend to take a facile view of migration as a cure for world population problems. The authors can scarcely be blamed for the present-day difficulties, which impose a time-lag on publication and which thus make some of the statistics seem a bit out of date and prevent any consideration of the influence of recent changes in the price of wool.

Bibliography of Electron Microscopy

Edited by Dr. V. E. Cosslett for the Institute of Physics. Pp. 350. (London: Edward Arnold and Co., 1950.) 40*s*. net.

THE electron microscope as a research tool is now about ten years old. During that period there has grown up an abundant literature, dealing with basic electron optical theory, with the production and interpretation of electron micrograms, with techniques for preparing specimens to meet the exacting requirements of the instrument and, latterly in particular, with its applications in many different branches of science and technology. Dr. V. E. Cosslett and his team have done an excellent job in preparing this comprehensive bibliography, which covers some 2,500 papers published up to the end of 1948. The field covered appears by test to be well-nigh complete, and abstracts are given of the majority of the papers included.

It is a pity, however, that the material has been arranged only in alphabetical sequence of authors. One would have thought that it would not have involved undue additional labour to have added a subject guide, or preferably to have arranged the items primarily by subject, with an alphabetical author index—a task which would have been greatly helped by numbering all the items in a single sequence. The very breadth of the subject-matter makes the lack of some such arrangement all the more regrettable, and it is to be hoped that any future volume will be improved in this respect. L. V. Chilton

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 30, 1950. Arthur C. Cope, Editor-in-Chief. Pp. vi+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 20*s*. net.

THE thirty-nine preparations described in this volume offer, as usual in this admirable series, a wide variety of substances and methods. The formation of *trans*-2-chloro*cyclo*pentanol from *cyclo*pentene is an interesting example of the use of monochlorourea, prepared from urea, as a source of hypochlorous acid. An attractive synthesis of ethanedithiol proceeds from thiourea and ethylene dibromide via ethylene di*iso*thiuronium bromide. Dihydropyran, obtainable by dehydrating tetrahydrofurfuryl alcohol, furnishes glutaric acid in excellent yield through hydrolysis and oxidation with nitric acid. The preparation of *cis*-Δ^4-tetrahydrophthalic anhydride by the addition of butadiene to maleic anhydride is described with a useful diagram of the apparatus furnishing a yield of 93–97 per cent. Among other preparations are fumaronitrile, methanesulphonyl chloride, 1-naphthaldehyde, phenylacetylene, *o*-tolualdehyde, vanillic acid and the vinyl esters of a series of the higher fatty acids.

John Read

Tropical Fishes as Pets

By Christopher W. Coates. Reprint. Pp. xi+226+29 plates. (London: Jonathan Cape, Ltd., 1951.) 12*s*. 6*d*. net.

THIS book has a much wider market than when it was first published seventeen years ago. For in that interval the number of people who keep tropical fish for pleasure or profit has increased enormously. Mr. C. W. Coates, who is a specialist in tropical fish at the New York Aquarium, gives good descriptions of most of the exotic fishes likely to be available to British aquarists.

After stressing that nobody should attempt to keep fish unless possessed of something called 'fish sense', he also provides four informative chapters on fish management. It is an unfortunate fact that the length of the technical names of these fishes seems to be inversely proportional to their body-length. Also Mr. Coates does not help matters for the lay reader by using the full scientific names; thus *Platypœcilus maculatus* is surely long enough for a one-inch fish without making it *Platypœcilus maculatus* Guenther.

The fifty-seven photographs are a mixed lot. A few are good, but too many are so dark that the fishes can barely be distinguished.

UNDULATORY PROPULSION IN SMALL ORGANISMS

By Prof. J. GRAY, F.R.S.
Department of Zoology, University of Cambridge

DURING a recent discussion[1] on the movements of bacteria, two main theories were advanced: first, that movement is due to the active undulations of numerous fine flagella, projecting from the surface of the cell and seen as fine wavy, but disorientated, filaments when the dead cell is examined under the electron microscope; and secondly, that propulsion is due to undulations of the whole cell, the so-called 'flagella' representing material sloughed off from the cell surface to form a twisted inactive tail. The object of the present communication is to consider these two theories in the light of four principles which have emerged from a study of other types of undulatory propulsion.

(1) From a mechanical point of view, there is no fundamental difference between an undulatory change in form by the whole cell and a similar change exhibited by a filamentous flagellum. All two-dimensional undulatory movements—irrespective of the size and internal structure of the organisms concerned—are expressions of two essential facts: first, that every part of the system is, by internal effort, bending alternately towards its 'right' and 'left' side; secondly, that the phase of the bending cycle exhibited by any unit length of the system is slightly ahead of that of the unit length lying immediately behind, but is slightly behind that of the unit situated immediately in front; in other words, the curvature at any region of the body is constantly changing towards that characteristic of the immediately anterior region, thus causing the wave to travel from 'head' to 'tail'. The form of the wave depends on two factors: the radius of curvature of a unit when bent to its maximum extent and the difference in curvature between successive unit lengths of the body, that is, on the difference in phase of bending per unit length. In order to execute these co-ordinated bending movements each unit length must possess: (i) tensile elements capable of shortening in length and of developing tension against the internal and external forces which oppose the process of bending; (ii) compression elements (equivalent in function to the vertebral column of an eel) which enable the energy of the tensile elements to be expended in the form of bending couples; (iii) a mechanism which controls the phase difference between adjacent lengths of the undulating system.

(2) Forward motion of the whole organism—whether it be a snake or a spermatozoon—occurs when the organism exerts its bending movements against external environmental resistance acting normally to the surface of the body.

Fig. 1*a* shows the general distribution of external forces acting against the body of an undulating organism. The forces (R) acting normally to the surface of the body are equal but opposite to the frictional forces (F) acting tangentially to the surface. Fig. 1*b* shows the relationship of the external forces acting against a single wave to the activity of the internal contractile elements. In the leading half of the wave AB, the contractile elements of the right side are shortening progressively from A to B and the body is thereby braced against the external resistances S_1, S_2 and S_3. The reactions R_1, R_2 and R_3 yield a resultant P_1 equal but opposite to F_1, F_1. Between C and A the contractile elements of the left side are shortening and the body is braced against S_4, S_5 and S_6, thus yielding a propulsive force P_2 equal but opposite to F_2, F_2. When the two half-waves operate together, the reactions from S_3 and S_4 are equal but opposite, and constitute transverse shearing forces at A.

Hence it can be shown that the forward propulsive thrust is proportional to the rate of change of curvature along the body and to the total length of the body; in other words, it is dependent on the form and speed of the waves.

(3) Effective propulsion in water only occurs when the body is long enough to exhibit at least one complete wave of sufficient amplitude, and since the form of the wave can be controlled experimentally by varying the physical condition of the medium the form can be changed to such an extent that the animal can no longer progress. This is particularly obvious in the case of short nematodes such as *Hæmanchus* or *Anchylostoma*, which creep with great efficiency through a relatively rigid medium such as agar. When placed in water the amplitude and wavelength of the undulation are increased to such an extent that the animal fails to form a complete wavelength along its body; under these conditions the animal does not progress, although it continues to display rhythmical undulations. The forms of these nematodes when in water are very similar to those of the bacteria in Pijper's photographs. (A detailed analysis of the movements of flagellated organisms

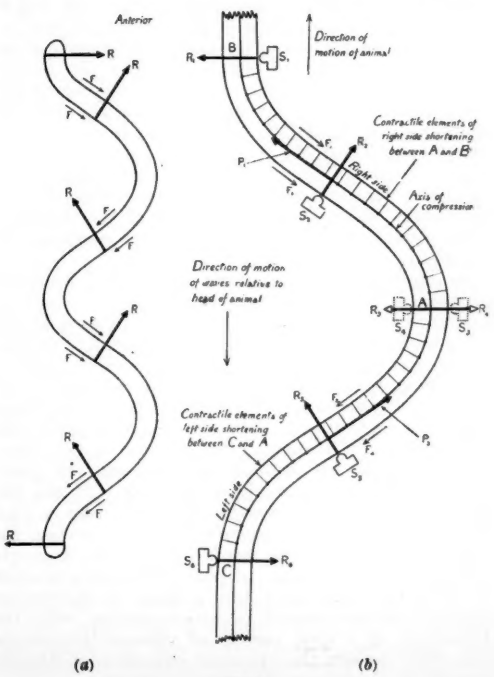
Anterior
Direction of motion of animal
Contractile elements of right side shortening between A and B
Right side
Axis of compression
Direction of motion of waves relative to head of animal
Contractile elements of left side shortening between C and A
Left side
(a)
(b)

Fig. 1

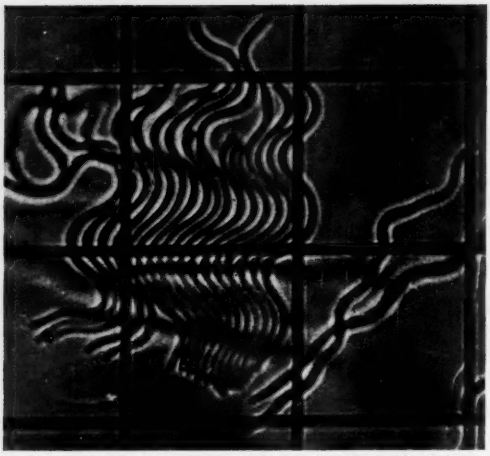

Fig. 2. Photograph of a group of living *Cristispira balbianii* showing synchronized movements in a thin film of water. The anterior ends of the organisms are attached to a glass slide. The sides of the black grid are 40 μ

in water is a formidable mathematical problem which is at present being examined by Sir Geoffrey Taylor.)

The sensitivity of wave form to external mechanical forces is a very widespread phenomenon among undulatory animals. A somewhat specialized but interesting example is shown in Fig. 2, which demonstrates the co-ordinated activity ensuing when two or more active organisms are sufficiently close together to exert mechanical forces on each other. These and other facts suggest that the difference in phase between adjacent regions of an active flagellum is controlled by the external physical forces acting against its surface.

(4) When a large animal (for example, an eel) is undulating in water, some of the energy required to bend the distal regions of the body and to drive these through the water are transmitted (by the body's own elasticity) from other regions lying nearer the head of the animal. In a flagellum, perhaps 0·5 μ in diameter, moving at 100 μ per second, the amount of energy which can be transmitted in this way is negligibly small compared with that required to move the flagellum against the viscous resistance of the water. Each short unit length of the flagellum must provide the whole of the energy necessary to maintain its own motion.

An application of these four principles to bacterial propulsion leads to the conclusion that the length of a bacterium and the ratio of amplitude to wave-length of its bodily undulations are both too small to sustain an efficient propulsive thrust. On the other hand, if the whole surface of the body were covered by an active sheet able to undulate with the wave-length and amplitude of the 'tails' shown in Pijper's figures, the organism would progress, and if some of this sheet were 'sloughed off' behind the organism, the 'tails' described by Pijper might well result. If the frequency of undulation were of the same order as that of the tail of the spermatozoon of a sea urchin, the waves would only be visible under stroboscopic darkground illumination. A post-mortem degradation of such an active sheet into a series of disoriented fibrillar elements would be in accordance with the behaviour of a wide variety of vibratile structures, and may explain the apparent existence of discrete flagella in electron micrographs of bacteria.

It is difficult to believe that disorientated fibrils such as those revealed by the electron microscope could propel a bacterium unless, during life, the fibrils are orientated in an antero-posterior direction. On the other hand, a series of active flagella in close proximity to each other would most probably develop synchronized movements. It would be very difficult to distinguish a true membranous sheath from a series of parallel filaments if both were propagating waves of identical form and frequency. From this point of view there seems little difference between the two theories.

A note of caution may perhaps be sounded concerning the functional interpretation of the fibrils and other structures revealed by methods which involve the destruction of the flagellum as an active dynamic system. The X-ray diffraction patterns of these fibrils suggest that their molecular structure is not dissimilar to that of hair and other natural fibres. The central problem is to endow such a system with three essentially dynamic properties: (1) the generation of internal bending couples; (2) the maintenance of phase difference in dynamical activity along the fibril; (3) the generation of free mechanical energy along the whole length of the fibril. To provide a picture of intra- or inter-molecular forces capable of meeting these requirements would be a major contribution to biology: at present, it is only possible to speculate how far internal bending couples could be generated within a long fibrillar molecule by a redistribution of intramolecular groupings of the type postulated by Meyer and Mark[2] and others for muscular contraction, the function of the vertebral column of the eel being performed by mutually repellent charges and that of the muscles by attractive charges. Such a system, if sensitive to mechanical stretch, would at least have some of the properties of an active flagellum, although there would still remain the necessity for periodic changes in the distribution of the charges concerned.

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GEORGE FRANCIS FITZGERALD, 1851-1901

CENTENARY MEETING AT THE ROYAL DUBLIN SOCIETY

G. F. FITZGERALD is unique in the history of modern science in that the fundamental hypothesis for which he is most remembered is one upon which he himself published nothing. This is the hypothesis that a moving body is contracted in the direction of its motion. Its historical significance can scarcely be over-estimated. For it asserts that the length assigned by an observer to a rigid body depends not only upon the body but also upon its relationship to the observer. It was therefore an attack upon the whole classical concept of space, according to which space possesses a geometry identical with that of a classical rigid body, the latter being supposed the same for all observers. Fitz-Gerald's suggestion was the first of those which led to the emergence of 'post-classical' physics.

FitzGerald's priority in this matter has never been questioned. As is well known, he made the suggestion in order to account for the null result of the Michel-

son–Morley experiment. Sir Oliver Lodge has told[1] how he had it from FitzGerald in 1892; H. A. Lorentz made the suggestion independently shortly afterwards, but then acknowledged FitzGerald's priority.

FitzGerald was born on August 3, 1851, the son of William FitzGerald, afterwards Bishop of Cork and later of Killaloe. His mother's brother was George Johnstone Stoney, who also anticipated a fundamental concept of modern physics, the electron, and to whom is due the current use of the term. As boys, FitzGerald and his brothers were educated at home, one of their teachers being a sister of George Boole. FitzGerald entered Trinity College, Dublin, in 1867, became a Fellow in 1877 and Erasmus Smith professor of natural and experimental philosophy in 1881. These appointments he held until his death in 1901, at the age of forty-nine.

FitzGerald was one of the prominent figures in late nineteenth century science. He is noted for a great deal more than the one hypothesis already mentioned; in fact, he is one of the most frequently quoted authors in Sir Edmund Whittaker's "History of the Theories of the Aether and Electricity" (second edition, Edinburgh, 1951). As early as 1883 he showed theoretically[2] that electromagnetic waves "of as little as 10m. wavelength or less" could be generated by oscillating electric circuits; and it is interesting to recall that in 1898 he took part in Marconi's demonstration in Dublin Bay of ship-to-shore wireless transmission which resulted in the first newspaper publication (in the Dublin *Evening Mail*) of news obtained by wireless. In 1888 he anticipated theoretically the modern use of the coaxial cable and wave-guides[3]. These are examples of his gift for throwing out brilliant suggestions which were much in advance of his time and which he himself did not pursue very far. Indeed, Oliver Heaviside wrote, "He had, undoubtedly, the quickest and most original brain of anybody. . . . He saw too many openings. His brain was too fertile and inventive. I think it would have been better for him if he had been a little stupid—I mean not so quick and versatile, but more plodding. He would have been better appreciated, save by a few." But his brilliance and versatility operated against the development of his own work also by laying him open to unceasing consultation by others, and he perhaps erred on the side of generosity in the help he gave. In addition, he played an influential part in the furtherance of university and technical education in Ireland.

A large proportion of FitzGerald's papers appeared in the *Proceedings of the Royal Dublin Society*, and he was from 1881 until 1889 honorary secretary of that body. On October 30, 1951, the Society devoted one of its scientific meetings to the celebration of the centenary of his birth. The chair was taken by the president, Major A. McMorrough Kavanagh, and afterwards by Dr. A. Went (committee-chairman). There were present one of FitzGerald's sons, Sir Raymond FitzGerald, a daughter, Mrs. Scott, and other relatives. The Physical Society of London, of which FitzGerald had been president in 1892, was represented by Prof. K. G. Emeléus. Messages were received from the Institution of Electrical Engineers, of the Irish Section of which FitzGerald was the first chairman (1899), from Sir Edmund Whittaker and from Dr. G. F. C. Searle, who had known him personally. The Provost of Trinity College, Dublin, Dr. E. H. Alton, gave personal reminiscences of FitzGerald, and quoted tributes to his character as a man in which his contemporaries had dwelt especially upon his complete freedom from considerations of his own self-interest. Dr. Alton also showed photographs[4], taken by J. Joly, of FitzGerald's pioneering experiments in human flight in a glider constructed by O. Lilienthal in Germany. Prof. F. E. W. Hackett (University College, Dublin) spoke of "FitzGerald as revealed by his letters to Heaviside". Photostat copies of the letters, presented by the Royal Institution, were on view at the meeting. Since the exchange of views between the two men depended almost entirely upon their correspondence, these letters give much insight into the working of FitzGerald's mind. They are enlivened by that sparkle which, according to Praeger and Lodge, characterized his talk at a lunch-table or at a scientific discussion.

The main theme of the meeting was, however, the significance of the FitzGerald–Lorentz contraction. The noteworthy feature was the demonstration that this is still a live subject, the papers contributed being far from mere historical reviews. For it cannot be denied that there is at the present time a widespread reaction against the theory of *general* relativity on account of the difficulty of applying it to problems of interest, the still greater difficulty of knowing what the theory really signifies, and the lack of success of 'unified field-theories'. This situation itself was not discussed. It is mentioned here because it is resulting in the realization that there is still important fundamental work to be done in the *special* theory of relativity (using this term without reference to any one particular formulation of the theory) which is free from the objections to the general theory. The papers read at the meeting can be regarded as part of the outcome of the situation.

The chief address was by Dr. Herbert E. Ives (New York). He started his comprehensive and critical historical review with a precise statement of the relation of FitzGerald's hypothesis to the Michelson–Morley experiment. He recalled how FitzGerald's contemporary, Sir Joseph Larmor, had accepted the hypothesis and had remarked in 1900 that it required as a consequence the phenomenon of 'time-dilatation'. Dr. Ives emphasized the really fundamental step which FitzGerald made in compelling us to take explicit account of the behaviour of measuring instruments and also to scrutinize the language employed, which had been developed on the assumption of invariant instruments. Thus he saw in FitzGerald's hypothesis "the germs of what are now called 'the operational principle' and 'semantics' ".

Dr. Ives proceeded to an account of the work of H. A. Lorentz and Henri Poincaré. Lorentz endeavoured to extend to all electrodynamic phenomena the invariance with motion found in the Michelson–Morley experiment. Seeking a principle that would comprehend all the particular ideas of Lorentz, Poincaré formulated[5] in 1904 "the principle of relativity, according to which the laws of physical phenomena should be the same, whether to an observer fixed, or for an observer carried along in a uniform motion of translation, so that we have not and could not have any means of discovering whether or not we are carried along in such a motion". Poincaré then gave the Lorentz transformation in the form in which it is known to-day, though this was a modification of Lorentz's original form.

Dr. Ives then described his own[6] 'operational' derivation of this transformation, assuming only Poincaré's relativity-principle and the accepted result that the velocity of light is independent of the

velocity of its source. In terms of his operationally defined quantities, the equations are complicated. "This is the price we have to pay," he said, "for equations which tell a complete and unambiguous story in symbols all of which have a definite operational meaning." However, a change of variables does, in fact, yield the standard form of the Lorentz transformation. One takes it that this substitution provides an explicit operational representation of the clock-synchronization, etc., required, but less carefully examined in more familiar treatments. Dr. Ives went on to a careful inspection of the "principle of the constancy of the velocity of light" which, as usually understood, he rejects.

He described also his well-known experimental verification[7] of the time-dilatation using the spectra of canal rays, following a suggestion originally made by J. Stark[8] and employing A. J. Dempster's method of accelerating canal-ray particles.

Dr. G. J. Whitrow (Imperial College of Science and Technology, London) contributed a paper on "The FitzGerald–Lorentz Contraction Phenomenon and the Theories of the Relativity of Galilean Frames". In the author's absence, it was described by Prof. W. H. McCrea. Dr. Whitrow started by quoting Bishop Berkeley's criticism of Newton's introduction of absolute motion into natural philosophy. The dilemma of Newtonian physics was that, while it held good for all Galilean frames in uniform relative motion, the phenomena of rotation seemed to demand an absolute standard of rest. In nineteenth-century physics this was provided by postulating the luminiferous æther. But the Michelson–Morley experiment demonstrated the impossibility of measuring linear motion through the æther. Einstein's formulation of the theory of special relativity again replaced the æther by empty space, but again gave no explanation of rotational phenomena. E. A. Milne's theory of kinematic relativity and world-structure offered a solution of the difficulty. In his view, the whole system of galaxies, or rather the substratum which in the theory represents the smoothed-out system of galaxies, provides at every point of space an absolute standard of rest and non-rotation. But the theory[9] is complicated by a distinction between fundamental and subsidiary Galilean frames. Dr. Whitrow now proposes a modification of Milne's work which restores to it the formalism of special relativity. The consequence of the work of Milne and Whitrow is thus to provide special relativity with a cosmological background. Dr. Whitrow also related the problem to a view of the philosophy of science which he has recently developed[10].

A paper by Prof. W. H. McCrea (Royal Holloway College, University of London) on "The FitzGerald–Lorentz Contraction—some Paradoxes and their Resolution" dealt with the problem of the rigid rod in special relativity theory. According to the theory, the contraction denotes no intrinsic physical change in a moving rod. Nevertheless, an observer can 'trap' the rod in the contracted state and exhibit it as having undergone such a change. If we define a rigid rod as one through which an impulse can travel with maximum permitted speed (that is, the speed of light), then it becomes clear how such a physical change is produced in the process of stopping the rod. If it is stopped at the forward end, then the shortest length momentarily attained is, in fact, less than that given by the FitzGerald factor. It can be shown that the kinetic energy just suffices to supply the energy of compression without dissipation; consequently the 'rigid' rod can be regarded as being also perfectly elastic.

Prof. J. L. Synge (Dublin Institute for Advanced Studies), in his paper on "Effects of Acceleration in the Michelson–Morley Experiment", dealt also, but more generally, with the rigid-body problem. The definition he gave was in a form due to his pupil, Mr. G. H. F. Gardner, and is based upon the concept of a 'drag-point' in the body, together with a condition requiring that any particle of the body responds to the behaviour of the drag-point only with a delay corresponding to the time of travel of light from the point to the particle. This appears to reduce to McCrea's definition in the case of a one-dimensional body. The definition enables one to study the motion of a rigid body in accelerated motion relative to a Galilean frame. As Prof. Synge pointed out, the Michelson–Morley experiment is one upon the behaviour of such a body, the instrument being in accelerated motion on account of the rotation and revolution of the earth. He stated that Gardner's hypothesis predicts a null result for the Michelson–Morley experiment if the interferometer is loosely attached to the earth, as it appears to have been in the latest repetitions of the experiment which have, in fact, given the null result. On the other hand, if the instrument is rigidly attached to the earth, then the hypothesis predicts a definite result about three times that reported by Dayton C. Miller in his particular repetition of the experiment[11]. The provisional interpretation is that Miller's interferometer had sufficient rigid connexion with the earth to show part of the acceleration effect predicted by the new theory. But, as Prof. Synge took care to state, judgment must be suspended until the theory is tested by specially designed experiments.

All these papers will be published in a special number of the *Proceedings of the Royal Dublin Society*, and will be found to contain much more information than there has been space even to mention in this report.

W. H. McCrea

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RABBIT CONTROL IN AUSTRALIA: PROBLEMS AND POSSIBILITIES

THE story of the rabbit in Australia is so well known, so familiar an instance of the spread of an innocent introduction to plague dimensions, that fresh turns in its course must be spectacular to become news. For most of the world beyond Australia, there is the pest, and there are the problems of its control. Even in Australia itself, there has been perhaps a sense of inevitability that this prolific competitor for grazing must embarrass agricultural production, impede attempts to raise both old-

occupied and new land to higher levels of fertility and output, and, in fact, place a heavy burden on farmer and pastoralist to exercise control measures. But there is no complacency among the occupiers of land in Australia; in many areas the rabbit-proof fence has become almost as typical a part of the Australian scene as is the gumtree or the Merino sheep, while in Western Australia the 'rabbit-proof fences', State-erected, State-maintained, and State-patrolled, stretch hundreds of miles across the continent to appear, like the Great Wall of China, a monument to the efforts made to stem the invader.

Always the pest has proved highly resistant to any attempts to confine it to limits of area in which it could be effectively tackled by such techniques as digging out warrens, gassing or poisoning, chasing by dogs and trapping, or even to restrict its numbers by such means. The general problem of its control is so severely practical that until about the late 1920's the possibility of scientific aid appeared almost as remote as that of complete eradication of the pest population. The recognition that the virus disease, myxomatosis, might be an agent in reducing rabbit numbers directly invoked scientific inquiry, and although early investigations carried out by the Division of Animal Health and Production, of the then Council for Scientific and Industrial Research, established that the disease could work, its effectiveness was small because of its very limited powers of spreading naturally through rabbit populations and groups. What did emerge, however, was that the problem, scientifically, had to be regarded as a whole, and that the rabbit and its context were fit material for comprehensive biological study.

During the Second World War and its aftermath, difficulties of labour and increasing costs of material for control measures, among others, gave rise to conditions favouring the rabbit. Also, increasing recognition of the importance of ecological and other biological approaches to such field problems ripened the opportunities for long-term research and encouraged the Commonwealth Scientific and Industrial Research Organization to include review of the rabbit problem in the programme of its Wildlife Section, established in 1949, without at the same time offering any optimism of revolutionary systems of control. The Organization has now issued "The Rabbit Problem—a Survey of Research Needs and Possibilities"*, in which F. N. Ratcliffe, officer-in-charge of the Section, assesses the scope for the different control methods, and presents a valuable, critical appraisement of the complex position to be studied.

In broad terms, Ratcliffe distinguishes qualitative differences in the problem, in three categories of country: "(*a*) the relatively low-value, low-rainfall grazing country (typified in N.S.W. by the Western Division); (*b*) the region of high-value grazing country (sheep to an acre or better, down to, say, one sheep to two acres); and (*c*) the closely settled farming areas". In the first, real control is impracticable, mitigation is possible, but serious infestations are limited by adverse climatic conditions; in the last, good farming practice usually keeps the rabbit under control. In the better pastoral country, which includes much of the land amenable to pasture improvement and the wheat areas, the rabbit problem is most acute and most severe economically, not so much from the direct damage as from the tremendous burden, in labour and expenditure, of measures to curb infestation from attaining catastrophic proportions; here, the real need is "for ways and means of bridging the gap between partial control and eradication".

Attempts to use pathogenic micro-organisms in the control of mammal pests have not generally been promising, but there were indications that the use of myxomatosis might give a cheaper method than others of checking rabbit numbers *in the higher-value country*; accordingly, trials were begun to introduce the virus into warrens in this category of land. But the first attempts failed to induce an effective spread of infection.

The survey records the position of other control methods in use, of which fumigation is probably now the most important. Gas is either blown through a burrow system, or is laid to form a zone of lethal concentration at the burrow mouth; carbon monoxide, 'Cyanogas' and carbon disulphide are used for blowing, 'Cyanogas' and chloropicrin are used as barrier zone fumigants. Neither method gives 100 per cent kill owing to the difficult natural conditions under which the fumigants are called upon to operate in the burrows; the choice of compounds possible for use is small, and the only hope appears to be improvement of the standard materials, especially chloropicrin. No effective 'persistent' fumigant has so far been found. Mechanical treatment of warrens by digging out formed a major control method in better-class country, and is now largely superseded by tractor ripping; while this loses effectiveness on stony or hilly land and among tree roots, its potential contribution to control is high when used as part of a planned campaign. Poisoning can kill large numbers of the pest, and its most effective use in reducing infestations is achieved by specialists who have accurate knowledge of the ecology of rabbit populations. The idea of using lures to poisoned baits is popularly attractive, but the evidence is that their effectiveness depends upon prevailing conditions rather than on any special attributes of the odour employed. "Of all the methods of rabbit destruction available, poisoning stands most in need of scientific study and clarification."

No particular promising line of inquiry which might lead to revolutionary new control methods emerges from the survey. There are possible minor improvements in fumigants and fumigation; probable major developments in efficiency of poisoning, but only after prolonged investigations; and a clear need for detailed ecological studies, on the results of which a sound national policy can be planned and put into effect. The report concludes by proposing a scheme for an "experimental area-control campaign" to determine the conditions under which the various control methods can best be integrated to meet local expressions of the problem; for example, to elucidate the conditions under which the target of local eradication must be replaced by that of mitigation and control. But in any such campaign, experimental or as a widely applied policy, the provision of rabbit-proof netting is seen to be essential to separate the areas in which eradication is practicable from those in which it is not.

Thus this report. But as it was prepared, a spectacular development occurred in the development of myxomatosis epidemics. It was known that the disease could be spread from sick to healthy rabbits by certain mosquitoes. As mentioned above, the first

* The Rabbit Problem: a Survey of Research Needs and Possibilities. Pp. 17. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.)

attempts to establish the disease in experimental sites were unsuccessful, but by continuing the introduction into warren colonies in the Murray River valley into the summer months of 1950–51, conditions favourable to success were encountered and mosquitoes rapidly spread the disease, so that by February 1951 the disease was reported widely in the Murray River system and its incidence had extended northwards along the Murrumbridgee, the Lachlan, and the Darling Rivers, almost up to the Queensland border, but with a slower spread south of the Murray.

Most effective transmission and high rabbit mortality were largely restricted to narrow zones of river frontages and to swampy areas where the dusk-biting *Culex annulirostris* was prevalent; but it was soon evident that 'jumps' of infestation were attributable to the day-biting *Aedes*, which are more widely distributed over open country. Local recessions of the epidemic occurred as the autumn season advanced. The Commonwealth Scientific and Industrial Research Organization had issued recommendations to graziers as to how to set up fresh loci of infection by moving infected rabbits; but by June it had announced that the first great epidemic had passed, leaving a probable toll of millions of rabbits killed and a vast saving of expenditure on control measures and of valuable fodder, over an area "about half the size of the continent of Europe". While the mosquitoes had been the main agents in spreading the epidemic, it was soon recognized that the small black fly *Simulium* was also involved and, later, that the smaller 'true' sandflies are important carriers, especially in parts of Queensland.

Extraordinary local differences in infestation occurred, but there is little doubt that the general direction and vastness of spread were affected by the unusual distribution of conditions that had obtained. Many parts of Victoria had suffered from drought, and there was little spread of the disease south of the Murray valley; to the north, the season had been wetter and wetter, and in parts of northern New South Wales and Queensland the widths of the effective killing zones had become greater, to give almost a general epidemic. The region in which the disease had its most profound effects, namely, those areas west of the foothills of the dividing range watered by the upper tributaries of the Darling River, had experienced some of its worst flooding on record.

Obviously, many questions remain for scientific workers and graziers to answer regarding the potentialities of the disease as an agent, and the conditions under which it can be expected to exert its contribution to a general campaign of control. Plans have been made for future distribution of the virus; but it is emphasized that there are many areas, such as high-value hilly country, where the rabbit is a serious pest, in which it can have little effect, and other measures of control must be pursued. Moreover, recovered animals have been found in some areas, possibly due to the appearance of virus strains of lower virulence; this opens up further questions for study, although in practice any acquired immunity, or variations in virulence, would only have temporary or local effects against the influence of fresh inoculations of the lethal strain.

Among notable instances of biological control, Australia has already provided the case of the pricklypear; it may be that this further chapter in the story of the rabbit in that continent will introduce a record of an achievement of equal or higher rank in the annals of its pastoral and agricultural development. For the moment, it is appropriate that this chapter should end by noting (*vide The Times*, October 18, 1951) that three of the scientific men who had taken leading parts in the programme, Dr. I. Clunies Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Sir Macfarlane Burnett, director of the Walter and Eliza Hall Institute, and Prof. F. J. Fenner, head of the Department of Microbiology in the Australian National University, themselves were inoculated with myxomatosis to allay doubts as to possible effects of the virus on man.

J. E. Nichols

RECENT RESEARCH AND ADDITIONS TO THE BRITISH FLORA

THE flora of the British Isles is probably better known than that of any other area of comparable size, and yet important discoveries can still be made. The annual exhibition meetings of the Botanical Society of the British Isles afford opportunities for bringing new plants, and the results of recent research, to the notice of botanists, and the one held in the lecture room of the British Museum (Natural History), South Kensington, on October 20 provided ample evidence that field and herbarium work in 1951 had been exceptionally productive.

The outstanding discovery of the year was that of *Diapensia lapponica* L. on a Scotch mountain, thus adding a new family—the Diapensiaceæ—to the British flora. This arctic-polar species, forming dense cushion-like tufts with crowded, imbricated, cartilaginous leaves, and with peduncles some 2 cm. tall bearing solitary white flowers 1·5–2 cm. across, was discovered very locally by C. F. Tebbutt, an ornithologist, on a mountain top in Westerness. It was represented at the exhibition meeting by a fine series of photographs by J. E. Raven and by the specimen sent by the discoverer to the Royal Botanic Gardens, Kew, for identification.

Mr. Raven also exhibited photographs of *Kœnigia islandica* L., a small annual member of the Polygonaceæ, with a circumboreal distribution extending as far south as the Himalayas in Central Asia. This was recently detected at Kew from specimens collected in Skye in 1934[1] and was re-found in June this year by Miss M. McCullum Webster. Mr. Raven's photographs showed that in Skye it grows in open damp places and that it is often gregarious. His observations and pictures indicate that it extends over a much wider area than could be deduced from the notes on the labels of the Kew specimens.

Two exhibits showed species originally recorded by G. Don (1764–1814), whose "reputed discoveries" have caused so much controversy among British botanists. Of these, the most surprising was *Homogyne alpina* (L.) Cass., found by A. A. P. Slack in 1951 in "the parish of Cortachy and Clova", Angus, and shown by B. W. Ribbons. Don said it occurred in the mountains of Clova "as on a rock called Garrybarns"[2]; but hitherto no other botanist has succeeded in re-finding it. The exhibitor is anxious to obtain evidence which will help in identifying "Garrybarns". *H. alpina*, formerly known as *Tussilago alpina*, is widespread in the mountains of Europe but

absent from Scandinavia. The other plant originally found by Don which was represented among the exhibits was a grass, *Rœgneria doniana* (F. B. White) Melderis (*Agropyron donianum* F. B. White). Since his time this has been found at intervals in the Breadalbanes[3]; but it appears to have been seen prior to 1951 by only three living botanists, and the specimens taken by two of these remained unidentified until this summer. The species was illustrated by photographs taken by Mr. Raven in the Breadalbanes and also near Inchnadamph, where he rediscovered it after identification of an earlier unnamed specimen in E. S. Marshall's herbarium.

Among the rediscoveries, though of a different status from that of the Scotch plants just mentioned, must be classed B. W. Ribbons's exhibit of *Acanthus mollis* L. from St. Agnes, Isles of Scilly. It was recorded from here in 1851[4]; but was regarded as extinct until he re-found it recently on private ground in a place which may well have been the original station.

The exhibit provided by the Department of Botany of the British Museum (Natural History) illustrated other aspects of the present phase of rapidly increasing knowledge of our flora. It included, very appropriately, a selection of specimens from the Department's herbarium connected with papers recently published in *Watsonia*, the journal of the Botanical Society, including types of new species described therein. Among the British herbarium material displayed were: *Myriophyllum verrucosum* Lindley, *x Mentha smithiana* var. *angustifolia* R. Graham, *Epipactis pendula* C. Thomas, *Rubus watsonii* W. H. Mills, *Equisetum ramossisimum* Desf., *Epipactis cambrensis* C. Thomas, *Milium scabrum* Merlet, *Orchis cruenta* Muell., and *Scutellaria hastifolia* L. (in sequence of publication[5]). An interesting fern exhibit was *Polypodium regium* as in "Hortus cliffortianus", 1737, with specimens from Vaillant and from Clifford's herbarium, and as gathered by C. E. Salmon in Teesdale in 1892 and 1911 under the name of *Cystopteris alpina*. It does not appear to have been seen in Britain recently. Dr. A. Melderis exhibited two British grasses, *Sesleria varia* (Jacq.) Wettst. and *Phleum commutatum* Gaud., for comparison with the closely related foreign *S. cærulea* and *P. alpinum* with which they have long been confused in Britain.

Among the exhibits by workers at the Botany School, Cambridge, were living plants of the two species of *Sesleria* mentioned above, shown by Dr. S. M. Walters. The true *S. cærulea* (L.) Ard., which can be readily distinguished by the easily removed waxy covering to the upper leaf surface, is Scandinavian and East European; our plant, which also occurs in Iceland and Western and Central Europe, is *S. varia* (Jacq.) Wettst. The remarkable difference in the appearance of the upper leaf epidermis, including the stomata, was demonstrated with the aid of a microscope slide. Dr. Walters also exhibited live and dried material of *Alchemilla subcrenata* Buser recently discovered in Teesdale. This is a common European species for which previous records in the British literature were false identifications. A sheet of *A. obtusa* Buser was shown, collected in September 1951 from the only known British locality[6]. He also included sheets of an '*acutidens*'-type *Alchemilla* from the Ben Lawers range which seems not to be identical with any described Scandinavian, British or Alpine species.

Also from Cambridge, D. E. Allen demonstrated the four species he recognizes in the aggregate *Cardamine pratensis* in Britain. The provisional names given are: *C. dentata* Schultes ($2n = 32$), *C. fragilis* (Dégl. ex Lloyd) Bor. (chromosome number unknown), *C. pratensis* L. emend. ($2n = 56$) and *C. polemonioides* Rouy ($2n = 64$). The species are morphologically quite distinct, although the last two, at least, hybridize freely wherever they meet, and each has a different geographical range. Increase in chromosome number can be correlated with a more northerly range, a greater tolerance of acid soils, and a reduction in stature, in leaf-size (especially in the lamina of the upper leaflets) and in style-length. C. D. Pigott exhibited 'point' distribution maps of the three British species of *Thymus* based wholly on localities derived from herbarium material. It was interesting to note that further work had not greatly extended the range of the rarest species—*T. serpyllum* L. em. Mill. P. D. Sell and Dr. C. West showed specimens of eight British *Hieracia*, all local endemics, which had been recently rediscovered. In some cases, for example, that of *H. macrocarpum*, more than fifty years had elapsed since their original discovery.

Recent work at University College, Leicester, was represented by several exhibits. Prof. T. G. Tutin showed *Poa annua* and the allied *P. infirma* and *P. supina*, with an artificial hybrid between the two first-mentioned species. *P. infirma* is now known from Cornwall[7] as well as from the Channel Islands, but *P. supina* has not yet been found in Britain. Prof. Tutin also showed two subspecies of *Heracleum spondylium* from England. The English common plant is subspecies *australe* (Hartm.) Neuman, but he also found subspecies *sibiricum* (L.) A. and G. in Norfolk. They differ in flower, fruit and leaf[8]. Miss E. W. Davies had an interesting example of polyploidy in *Primula farinosa*. Swedish material examined had been found to have double the number of chromosomes of plants from Widdy Bank Fell, Durham, which differed in leaf characters. She also showed Somerset material of *Carex demissa* Hornem., *C. serotina* Mérat, and a suspected hybrid between them, and also an example of hybrid vigour in *Asplenium adiantum-nigrum*.

Blackberries have long been regarded as a puzzling critical group, and W. C. R. Watson's exhibit of *Rubus villicaulis* with a revised list of the series Subvirescentes is likely to make further changes necessary in British floras. In contrast, little work has been done on the species of *Oxalis* which occur as aliens in Britain. Dr. D. P. Young displayed herbarium material of twelve alien species in addition to the native *O. acetosella* and several varieties. Most of the names will be new to workers here. *Schœnus nigricans* is generally regarded as a plant subject to very little variation; but P. J. Newbould's dissections and diagrams show that even in this species there is much to learn. Miss J. P. Pugh showed specimens of *Dryopteris borreri* with the characters indicated and the allied species, from which it has been recently separated, for comparison. Her work has already shown that this fern occurs more widely than was suspected. P. F. Yeo showed a putative hybrid between *Polygala calcarea* and *P. vulgaris* from Somerset.

Exhibits of fresh material included twenty pots of wool aliens collected by Dr. J. G. Dony and J. E. Lousley in Bedfordshire. These were mostly of Australian origin and had been brought to Britain as seeds or fruits in wool. Some of these foreign plants are now locally common in districts where

'shoddy', in the form of waste from woollen mills, is used as a valued manure. Most of them are very sensitive to frost and unlikely to persist as weeds. P. Greenfield showed a living plant of *Cystopteris dickieana*, a fern known only from sea-caves near Aberdeen, where it may be extinct.

The organization of the work of revising the Flora of Warwickshire was demonstrated by P. S. Green. This included printed cards for recorders to use in sending in records, outline maps, circulars to contributors setting out instructions for collecting material of critical groups, and the "Flora Bulletin" for circulating information about the progress of the work. Coloured drawings of plants by Miss W. M. A. Brooke, Dr. J. T. Burgess (prepared 1879–1900), Miss H. D. Garside, Miss M. Knox, Rev. W. Keble Martin, Mrs. B. H. S. Russell and Miss P. Woodlands (from the Glasgow Natural History Society), and photographs, maps, manuscripts, books and herbarium specimens from other contributors were also displayed.

The general impression which the exhibition meeting left in my mind was that work on British field botany is progressing faster than ever before. This is no doubt primarily due to the renewed interest in taxonomy at the universities, as evidenced by the exhibits. But their research is also assisting the work of other centres of study and it is helping the amateur botanist to direct his energies to more profitable channels. As a result, field botany in Great Britain has had an exceptionally successful season.

J. E. Lousley

[1] Burtt, B. L., *Kew Bulletin*, **2**, 266 (1950).
[2] Druce, G. C., *Notes R.B.G., Edin.*, **12**, 112 (1904).
[3] Druce, G. C., *Rep. Bot. Soc. and E.C.*, **9**, 95 (1930).
[4] Babington, C. C., *Ann. Nat. Hist.*, Ser. 2, **8**, 505 (1851).
[5] *Watsonia*, **1**, 63, 89, 102, 135, 149, 284, 345, 366 (1949–50); **2**, 18 (1951).
[6] Walters, S. M., *Watsonia*, **1**, 13 (1949).
[7] Raven, J. E., *Watsonia*, **1**, 357 (1950).
[8] Thellung, A., and Hegi, G., in Hegi, G., *Ill. Fl. Mittel-Europa*, **5** (2), 1430 (1926).

OBITUARIES

Dr. R. G. Aitken

We have learned with much regret of the death on October 29, in his eighty-seventh year, of Dr. Robert Grant Aitken, director emeritus of the Lick Observatory, California. Born at Jackson, California, on December 31, 1864, Aitken was educated at Oakland High School and Williams College, Massachusetts. During 1891–95 he was professor of mathematics and astronomy in the College of the Pacific. In 1895 he joined the staff of the Lick Observatory, where he was to remain throughout his active career. William Joseph Hussey, professor of astronomy at Leland Stanford University, was at that time a volunteer observer at the Lick Observatory, and in 1896 he also was appointed to the staff. Aitken and Hussey almost at once embarked on a systematic survey of all stars down to magnitude 9·0 on the *B.D.* scale in the portion of the sky from the north pole to 22° south declination for the detection of double stars.

The survey was made at first with the 12-in. refractor, the great 36-in. refractor being used only to verify the duplicity of all discoveries. But soon the survey and the measures were made solely with the larger telescope. After Hussey left the Lick Observatory in 1905 to become director of the Detroit Observatory, Aitken carried on the survey alone, and eventually completed it to 18° south declination, the South African double-star observers taking over the responsibility for the remaining portion of the sky. In the course of this work, Aitken discovered 3,103 new double stars; Hussey, in his portion of the survey, had discovered 1,327. Throughout the survey an upper limit of separation of 5″ was fixed, but for more than half the new discoveries the separation was less than 1″.

Aitken did not restrict himself to discoveries of new binary systems. He re-measured each of his own stars at two subsequent epochs in order to detect orbital motion, while stars of special interest were observed more frequently. In the course of his work a large number of measures of known binaries, and particularly of those showing orbital motion, were made. He also computed a large number of orbits.

His observations were characterized by a high standard of accuracy, and the measurements of even the closest pairs were affected by only small accidental errors. Of special interest is the pair Aitken 88, which he discovered in 1901; the period of this binary system is only 12·2 years and the maximum separation 0·17″. Aitken observed it right round its orbit and computed the orbital elements, no other observations of this difficult pair being obtained by any other observer.

The homogeneous material obtained in this great survey was used by Aitken for various statistical studies. It is of interest to note that about one star in eighteen of those examined was capable of visual resolution as a binary star.

In 1932 Aitken published the "New General Catalogue of Double Stars within 120° of the North Pole". This work was planned to supplement the "General Catalogue" published by Burnham in 1900. On his retirement from the Yerkes Observatory, Burnham had turned over the material that he had collected for the revision and extension of his catalogue to Prof. Eric Doolittle, director of the Flower Observatory. After the death of Doolittle in 1920, the whole of the material was taken over by Aitken in accordance with a promise he had made to Doolittle in 1919. In this great work is given for each pair the earliest available measure and all later measures except those quoted or referred to by Burnham. The wider and fainter pairs were omitted, however, as unlikely to be physical doubles. Aitken set a limit of separation of 10″ for a pair with apparent magnitude of 9·0, with appropriate limits for brighter and fainter pairs. About thirty per cent of Burnham's pairs were thereby excluded, yet the new catalogue has 17,181 entries as compared with Burnham's 13,665.

In 1918 Aitken published "The Binary Stars", an authoritative and comprehensive survey of every aspect of double-star astronomy, which has proved invaluable both as a text-book and as a work of reference. A revised and enlarged edition was published in 1935.

The observation of double stars is of great importance for the information it provides about the masses of the stars. It remains one of the few fields of work in which observations (except for wide pairs) must be made visually. The glamour of astrophysics has unfortunately resulted in the almost complete neglect of double-star observations, at least in the northern hemisphere. Aitken was one of the great exponents

of double-star astronomy in all its varied aspects; throughout his active career he pursued it with single-minded detachment, using to the full the advantages provided by the great 36-in. refractor and the excellent conditions for observation on the summit of Mount Hamilton.

Aitken was appointed associate director of the Lick Observatory in 1923 and director in 1930; he retired in 1935 with the title of director emeritus. After his retirement he continued to take a keen interest in astronomy. He was in great demand as a lecturer and was very active in the affairs of the Astronomical Society of the Pacific; at the time of his death he was chairman of its Board of Directors. He was elected an associate of the Royal Astronomical Society in 1913; he was awarded the Catherine Bruce Gold Medal of the Astronomical Society of the Pacific in 1926 and the Gold Medal of the Royal Astronomical Society in 1932. He married in 1888 Jessie, daughter of Captain W. R. Thomas, and there were three sons and a daughter of the marriage.

H. Spencer Jones

Prof. C. K. Tinkler

The death on October 25 of Prof. C. K. Tinkler, formerly professor of chemistry in King's College of Household and Social Science, University of London, will be felt as a loss in many circles, particularly in the world of women's education—a world in which he ranked as a pioneer.

Prof. Tinkler was born in 1881 and received his early education at Caterham School. It was here that he first met V. H. Mottram, who on his appointment in 1920 as professor of physiology in King's College became his colleague and close associate. Tinkler graduated from the University College of North Wales, Bangor, and afterwards went to the University of Edinburgh to work under Prof. J. J. Dobbie. In 1904 he became a lecturer in the University of Birmingham, and during the following eleven years worked intensively both in teaching and research. He published many papers on alkaloids of the berberine type and cognate compounds, made a study of fuels, and in collaboration with a fellow lecturer published a book much valued in the petroleum industry, "The Chemistry of Petroleum", by Tinkler and Challenger.

In 1915 he was appointed a reader in the University of London and head of the Chemistry Department of King's College of Household and Social Science, then the Home Science Department of King's College for Women. It was to the work and development of this College that he devoted the remaining thirty-two years of his professional career until his retirement in 1947.

To understand fully the main achievements of Prof. Tinkler's life it is necessary to look back at the history of the College with which he was so closely identified. At the time of his appointment, the College was in its infancy. Only seven years previously, in 1908, a course dealing with the scientific and social aspects of the household and institution had been run for the first time in a department of King's College for Women, a branch of King's College, Strand. In those days the idea that there could be any connexion between pure science and the mundane affairs of the kitchen and laundry was revolutionary, and still more revolutionary the idea that a liberal academic education for women could be based on subjects within their own sphere. Nevertheless, a few great men of vision, Sir John Atkins, Sir Cooper Perry, Sir Herbert Jackson and Prof. A. Smithells, were convinced of the scope and necessity for this type of education for women; they devised and initiated the course, and collected by private enterprise sufficient money to acquire a site on Campden Hill, Kensington, and to begin building a college. If any justification of their faith be required, it is to be found in the universal acceptance to-day of their ideas and in the progress and expansion that have taken place in every aspect of the field they sought to cover: for example, in the science of foods, detergents, house-heating and ventilation, and even in the study of the social and economic relationship of the home to the community and the nation.

It was by a stroke of good fortune that Prof. Tinkler became a member of the small staff in 1915, for he was imbued by the same ideas, and threw himself whole-heartedly into the task of developing the course and establishing the College and its work. His arrival took place at the opportune moment when the first instalment of the building, including the laboratories, was erected but not yet equipped. Here then was a situation calling for those qualities with which Prof. Tinkler was well endowed—organizing ability, initiative and enthusiasm born of his ever-increasing and infectious faith in the whole project.

Success came with the years: in 1920 a professorship was conferred upon him by the University of London, in 1921 the course was recognized by the University by the granting of the degree of B.Sc. (Household and Social Science), and in 1928 the College was recognized as an independent school of the University and given its present title. In the development, Prof. Tinkler was the leading spirit. His personality, combined with wisdom and knowledge, rendered him an invaluable committee member, an able representative of the College in the outside world, and the man to whom people instinctively turned for guidance in all matters, whether academic, practical, or administrative. Within his own department he applied himself from 1915 onwards to the task of devising a suitable course in chemistry to dovetail with the other subjects in the curriculum. In collaboration with Miss Helen Masters he created a course in applied chemistry unique in its scope and to the present day regarded as a model in home science departments throughout the world. The results of original work were embodied in this course from time to time. The practical work and some of the better established aspects of theory were published in two volumes: "Applied Chemistry", by Tinkler and Masters.

As a teacher, Prof. Tinkler excelled. He possessed a great store of knowledge of a wide range of practical matters and had a remarkable gift of clear exposition and a rare capacity for bridging the gap between the academic and practical aspects of his subject.

Agnes Jackman

The death is announced of Mr. J. E. Southcombe, a director of Germ Lubricants, Ltd., at the age of sixty-six. He graduated at the University of Liverpool in 1907, and after a short period of teaching in Ireland returned to Liverpool to do chemical research. He collaborated with the late Henry M. Wells in an investigation of the properties of 'fatty oils', and their use as compounding agents with mineral oils for lubrication; and afterwards specialized on 'boundary phase' lubrication problems.

NEWS and VIEWS

British Association: Officers for 1952

The Council of the British Association announce the following appointments for 1952, which includes the annual meeting at Belfast (September 3–10): *President*, Prof. A. V. Hill; *General Treasurer*, Mr. M. G. Bennett; *General Secretaries*, Sir Richard Southwell and Dr. George Taylor; *Presidents of Sections*, *A* (Mathematics and Physics), Prof. A. M. Tyndall; *B* (Chemistry), Prof. W. Wardlaw; *C* (Geology), Dr. J. E. Richey; *D* (Zoology), Prof. A. D. Peacock; *E* (Geography), Prof. R. O. Buchanan; *F* (Economics), Prof. D. T. Jack; *G* (Engineering), Sir Ben Lockspeiser; *H* (Anthropology and Archæology), Prof. E. O. James; *I* (Physiology), Prof. R. C. Garry; *J* (Psychology), Prof. P. E. Vernon; *K* (Botany), Prof. Meirion Thomas; *L* (Education), Mr. A. L. Binns; *M* (Agriculture), Dr. N. C. Wright; *Conference of Delegates of Corresponding Societies*, Mr. J. A. S. Stendall. The Prime Minister of Northern Ireland and the Lord Mayor of Belfast will be patrons for the Belfast meeting, for which a local executive committee has been appointed under the chairmanship of the Vice-Chancellor of Queen's University, Belfast, Dr. Eric Ashby.

International Council of Scientific Unions

The Executive Board of the International Council of Scientific Unions held its annual meeting in the rooms of the National Academy of Sciences at Washington, D.C., on October 16–17. Prof. A. von Muralt, president, was in the chair. In addition to the members of the Board, a number of American scientific men were invited to attend the meeting from the State Department, the National Academy of Sciences and various national committees, from the National Research Council and the Science Foundation. Among the items of business mention must be made of the fact that for the first time the Board allocated among the Unions the grants-in-aid for 1952 made by the United Nations Educational, Scientific and Cultural Organization. The total allowed for each category of grant was fixed by Unesco, and the internal distribution within each category by the Board. Applications for acceptance from the International Unions of Biochemistry and Scientific Psychology were deferred. A new Joint Commission on Electron Microscopy was set up, and a Committee on a Polar Year to be organized for 1957. A revised agreement with Unesco was approved. A new feature of a Board meeting was a symposium on "Development of International Co-operation in Science", at which the speakers were Prof. F. J. M. Stratton, Dr. W. A. Noyes, jun., Dr. J. N. Mukherjee, Dr. C. J. Mackenzie, Dr. Joseph B. Koepfli and Prof. A. von Muralt. Mr. William W. Rubey, chairman of the National Research Council, presided. At the close of the meeting, visits were arranged for delegates to a number of scientific institutions in Washington. Generous hospitality was offered by the National Academy of Sciences and its officers, and the Board was entertained to lunch by the Hon. James E. Webb, Under-Secretary of State.

Nature Reserve in Ross and Cromarty

The first national nature reserve in Britain has been established by the Nature Conservancy in the County of Ross and Cromarty. A property of some 10,450 acres within the great deer forest of Kinlochewe has been purchased by private treaty and declared a nature reserve by the Conservancy. The reserve includes the woods of Coille na glas Leitre by Loch Maree (surface elevation 32 ft.) and the eastern slopes and ridges of Beinn Eighe, rising to more than 3,200 ft. The very ancient geological formations of this region are of great interest and exhibit some of their more striking features within the reserve. The mountain scenery is particularly impressive, where the white Cambrian quartzite is most prominent upon the dark torridonian sandstone. There are several small lochans and pools on the moors. The woodlands are occupied predominantly by Scots pines and birches and are of considerable scientific interest as part of a system embracing woodland and transitional moorland areas. The moorlands, which are generally very wet, reach upwards to screes and steep rocks. In the high corries and on the exposed ridges the flora is arctic–alpine in character. Among the mountain plants are: alpine bearberry, purple saxifrage, mountain azalea, alpine thrift, moss campion and the dwarf cornel. The fauna of the district includes red deer, roe deer, wild cat, pine marten, golden eagle, buzzard and ptarmigan. The reserve as a whole, with its wide range of altitudes and its various woodland, moorland and mountain top habitats, offers excellent opportunities for biological observations and research in relation to nature conservation.

M. T. Kearney Foundation of the College of Agriculture, University of California

A new foundation, to be known as the M. Theodore Kearney Foundation of Soil Science, has been endowed in the College of Agriculture, University of California, with the proceeds of the bequest of the late Mr. Kearney, a prominent rancher in the Fresno area in the latter part of the last century, who died in 1906, leaving his estate to the University; the endowment now amounts to 2,268,000 dollars. The Foundation will be used for the advancement of knowledge of soil science, including soil–water–plant relations, by study of the basic physics, chemistry, biology and hydrology, with particular reference to arid and semi-arid farming regions; it will also serve to strengthen the services of the University in the education and training of soil scientists and teachers of soil science and closely related subjects. Mr. Kearney's interest in soil science arose from his experience of barrenness of soils resulting from alkali accumulations following irrigation. The current programme of the College of Agriculture includes research on the physical behaviour of soils, chemical problems of alkali soils and methods of cropping on them, both in the field and the laboratory, with the view of the permanent reclamation and agricultural use of such soils. Other studies include the behaviour of important chemical ions and their uptake by plants; direct fertility studies in relation to soil types; the palatability and nutritive value to livestock of forage crops produced on soils of different fertility levels; the clay minerals of the soil and the part they play in soil chemistry and physics; and soil surveys and land classifications of the agricultural, grass and forested areas of California.

Inter-Commonwealth Postgraduate Scholarships in Science

The Royal Society Empire Scientific Conference and the British Commonwealth Scientific Official Conference in 1946 recommended the preparation of a list of postgraduate scholarships available for scientific study within the Commonwealth. The task

of compiling a list was assigned to the British Commonwealth of Nations Scientific Liaison Office in London, and it has now published the required information in a book called "The Commonwealth Post-Graduate Scholarships in Science". Since the main objective of the list is to encourage the movement of scientific workers within the Commonwealth, only those awards open to members of at least one Commonwealth country or Colony other than the awarding one have been included. The entries are set out in tabular form showing, in addition to the names of the scholarships and the agencies awarding them, details of the fields of study, where tenable, duration and value, closing dates for applications and the addresses to which these should be sent. There are more than 350 separate entries in the list: many of these cover a number of scholarships so that the total number of available awards is much greater. The list should be a valuable work of reference for students and educational authorities and is published by H.M.S.O., price 5*s*.

Costantino Gorini Foundation for Dairying, Milan

A FOUNDATION in memory of Costantino Gorini, the dairy bacteriologist, who died in September 1950 in his native city of Milan, has recently been formed, under the auspices of the Lombard Institute of Sciences and Letters of Milan, for the purpose of assisting research workers engaged in dairy science and technology, especially in the field of microbiology. Periodically, an international competition will be held and a prize awarded for results in improving the production and uses of milk and dairy products in the interest of human nutrition. Entries for the present competition, for which the prize will be 100,000 lire, must be sent in before December 31, 1952, to the Istituto Lombardo, Via Brera 28, Milan. An entry must consist of a letter of application, supporting reprints of published work and an account of the research work completed since 1949; the reprints and the letter of application may be written in Italian, French, English, Spanish or German, but the account of the work itself must be in Italian or French.

Jaina Legend in Old Gujarati

A WORK in Old Gujarati ("The Nalarayadavadanticarita (Adventures of King Nala and Davadanti)", edited and translated by Ernest Bender (*Trans. Amer. Phil. Soc.*, **40**, Pt. 4, 1950) is a Jaina version of the Mahabharata story of King Nala and Queen Davadanti. Nala loses his kingdom at dicing to his younger brother and is exiled, taking the form of a hunchback at the command of his father's spirit. After adventures lasting twelve years he is reunited with Davadanti, assumes his natural form and regains his kingdom. The story is used as a discourse on the precepts of the Jaina religion, Nala's misfortunes and subsequent reinstatement being explained as the outcome of his actions in previous births. The book contains a comparison with the Mahabharata version, notes on metres and grammar, the Gujarati text in English script, and a translation, glossary and bibliography.

Isabelline Shrike on the Isle of May

IN September 1950 Miss Winifred Flower and Miss M. I. Kinnear observed on the Isle of May a shrike which did not appear to resemble any of the species described in "The Handbook of British Birds". Full details were forwarded to the late B. W. Tucker, who accepted the record as referring to the isabelline shrike (*Lanius isabellinus*). Later, Sir Norman Kinnear compared this material with specimens in the British Museum and confirmed the identification of what is a species new to the British list (*British Birds*, **44**, No. 7; July 1951). The breeding-range of the species *Lanius isabellinus* extends from Transcaspia and the southern Khirgiz steppes through Turkestan and Mongolia to southern Transbaikalia and Alashan and Ordos in inner Mongolia. Various authorities are in disagreement as to the ranges of the three subspecies *L. i. isabellinus*, *L. i. phœnicuroides* and *L. i. speculigerus*, but agree that the last is found in Mongolia and Transbaikalia. On migration the isabelline shrike travels south-westward through north-western India, Persia, southern Iraq, and southern Arabia to winter in Africa from the Sudan, Abyssinia and Somaliland south to Uganda and Kenya and west to the Lake Chad region.

Acetylene Industry and Chemistry in Germany during the War

THE Department of Scientific and Industrial Research has issued a booklet entitled "The Acetylene Industry and Acetylene Chemistry in Germany during the Period 1939–1945", by Dr. R. Owens and Dr. A. W. Johnson (pp. 157; London: H.M.S.O., 1951; 3*s*. 6*d*.). This is a substantial pamphlet and gives very detailed information on all aspects of acetylene chemistry, in which important advances were made in Germany during the war period. The processes include the thermal cracking of methane and other saturated hydrocarbons, and the manipulation of acetylene under pressure. The chemical industry will undoubtedly be grateful to H.M. Stationery Office for making available (and at such a low price) a compilation of this size and content.

Proceedings of the International Conference on Low Temperature Physics

THE *Proceedings of the International Conference on Low Temperature Physics* held in Oxford during August 22–28 (see *Nature*, November 10, p. 807) are now available and are being sent out to those who ordered them at the conference. The publication consists of illustrated reports of 106 papers on 165 foolscap pages produced by the 'Rotaprint' process together with a short summary of the discussions. It is of interest to see how prompt publication of this report has been achieved. Fifty reporters, drawn from research workers in the Universities of St. Andrews, Bristol, Cambridge and Oxford and Queen Mary College, London, were used, each of whom was allotted about an hour of conference time. They were asked to write about 350–400 words, and to choose the minimum number of diagrams, for each fifteen minutes they were 'on duty', and in most cases they were confined to lectures given by people from the same laboratory as themselves. Manuscripts submitted in advance were also dealt with by the reporters on this basis. In this novel way, the organizers of the Conference were able to receive promptly short trustworthy accounts of papers presented, and also adequate reports of the actual discussions, with the result that the present useful summary has been prepared under the editorship of Dr. R. Bowers and produced within three months

of the close of the Conference itself. Copies of the *Proceedings* can be obtained, price 15*s*., if orders are received by the Low Temperature Conference Secretary, Clarendon Laboratory, Oxford, before the end of the year.

Rhodes–Livingstone Museum

A somewhat unusual museum report is that of the Rhodes–Livingstone Museum in Northern Rhodesia (Pp. 44. Livingstone: Rhodes–Livingstone Museum, 1951. 2*s*.). The period covered is 1934–51, and it includes an account not only of its first home in the old Magistrate's Court in Livingstone, but also its present position in the United Services Club building, to which it moved in 1937. Finally, new buildings were completed in November 1950, mainly due to the generosity of local firms and private subscriptions. The aim in arranging the collections has been to create a friendly, pleasant atmosphere in which the visitor immediately feels at ease. Pale pastel shades predominate, and everything has been done to make a visit to the Museum a worthwhile adventure. The report also includes an excellent summary of the aims of museums in general and the policy of the Rhodes–Livingstone Museum in particular. This is a report of particular value to curators and all those who are interested in modern museum development.

University of Birmingham

Dr. O. E. Lowenstein, senior lecturer in zoology, University of Glasgow, has been appointed Mason professor of zoology in the University of Birmingham, in succession to Prof. P. B. Medawar. The following have been appointed lecturers in the University: Dr. H. R. Mulholland (mathematics); Dr. C. E. Harrold (botany); Dr. F. J. Wallace (mechanical engineering); and W. M. Crooks and D. C. Freshwater (chemical engineering). The following have been appointed research fellows in the University: Dr. J. M. Rushforth (mathematics); J. D. Lawson (geology); and Dr. A. R. Harding and T. Broom (metallurgy). The title of reader in thermodynamics has been conferred on Dr. F. K. Bannister, lecturer in the Department of Mechanical Engineering. Dr. R. T. W. Hall has resigned from his lectureship in chemical engineering on taking up an appointment with Esso Motor Spirit Co. at Fawley, Hants.

The Night Sky in December

Full moon occurs on Dec. 13d. 09h. 30m., U.T., and new moon on Dec. 28d. 11h. 43m. The following conjunctions with the moon take place: Dec. 7d. 10h., Jupiter 4° S.; Dec. 22d. 23h., Saturn 6° N.; Dec. 23d. 03h., Mars 6° N.; Dec. 25d. 14h., Venus 8° N.; Dec. 27d. 06h., Mercury 8° N. In addition to these conjunctions with the moon, Mars is in conjunction with Saturn on Dec. 19d. 13h., Mars being 0·7° S. In the early part of the month Mercury sets about an hour after the sun and is in inferior conjunction with the sun on December 17, after which it becomes a morning star and at the end of the month rises nearly two hours before the sun. Venus, a morning star, rises at 3h. 20m., 3h. 55m. and 4h. 35m. on December 1, 15 and 31, respectively, stellar magnitude varying from − 3·9 to − 3·6 and the visible portion of the illuminated disk varying between 0·58 and 0·70. Mars is a morning star, rising at 1h. 40m. on December 1 and at 23h. 50m. on December 31; in the early part of the month the planet is close to η Virginis. Jupiter is visible up to about midnight, setting at 1h. 40m. and 23h. 50m. on December 1 and 31, respectively. Saturn, a morning star, rises at 2h. 25m., 1h. 40m. and 0h. 40m. at the beginning, middle and end of the month, respectively, and in the last case is a little north-west of θ Virginis. Occultations of stars brighter than magnitude 6, observations being made at Greenwich, are as follows: Dec. 3d. 18h. 26·7m., 30 Capr. (*D*); Dec. 10d. 16h. 08·5m., ε Arie. *m*. (*D*). *D* refers to disappearance. The Geminid meteors are active during the first week of December. Winter solstice occurs on Dec. 22d. 16h.

Announcements

H.R.H. the Duke of Edinburgh will open the new laboratories at Stoke-on-Trent of the British Ceramic Research Association on December 12.

Prof. Albert Vandel, professor of zoology in the University of Toulouse, has been elected a *correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences in succession to Prof. Emile Guyénot, professor of zoology and comparative anatomy in the University of Geneva, who has been elected a non-resident member of the Academy.

The degree of D.Sc. in the University of London has been conferred on D. R. Bates (University College), Prof. C. H. Gray (King's College Hospital Medical School) and Miss Florence N. David (University College).

The Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation is arranging a symposium on meat production, to be held in Paris during December 18–20, at which scientific research workers and technologists will present papers on different aspects of the subject, both from the point of view of the producer and from that of the consumer. Further information can be obtained from the Secrétariat, Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation, 71 Boulevard Péreire, Paris, 17e.

The annual exhibition of the Television Society will be held during December 28–29 at Century House, Shaftesbury Avenue, London, W.C.2. The exhibition will be open as follows: December 28, 6–9.30 p.m., members and friends; December 29, 10.30 a.m.–5.0 p.m., members. The public is admitted by invitation card. All exhibits are closely related to television engineering or production or to the production of television programmes. Tickets of admission may be obtained from Society or patron members, or from the Lecture Secretary at 10 Tantallon Road, Balham, London, S.W.12.

The Institute of Rural Life at Home and Overseas is organizing a conference entitled "Rural Life at Home and Overseas", to be held at High Leigh, Hoddesdon, Herts, during January 1–4, 1952, under the chairmanship of the Rev. Dr. W. E. Farndale, a former president of the Methodist Conference and moderator of the Free Church Federal Council. Three lectures will be delivered: "Progress in British Agriculture", by Prof. H. G. Sanders; "A Sudan Experiment in Education", by V. L. Griffiths; and "The Church in the Village", by the Rev. A. K. Mathews. The fee for the conference (inclusive of board) is £3. Registration forms and further information can be obtained from the secretary of the Institute at 84 Eccleston Square, London, S.W.1.

ISOLATION OF NUCLEI FROM PLANT CELLS

By Dr. R. BROWN
Botany Department, University of Leeds

A CHANCE observation on the effect of pectinase solutions on plant tissues has led to the development of a technique for the isolation of nuclei. This technique may have several applications, since it can be used with the root tip, which is an important experimental object, and it yields nuclei in a comparatively undamaged state.

A method that can be used with certain plant tissues has already been described by Feulgen, Behrens and Mahdihassan[1]. These workers, after grinding dry rye embryos in a specially designed mill, centrifuged the dismembered tissue in a mixture of benzene and carbon tetrachloride. During centrifugation, nuclei collected in the upper layer and other cellular components settled into the lower. With this technique after drying the nuclei, Feulgen *et al.* were able to demonstrate the presence in them of deoxyribonucleic acid. It is evident, however, that with this procedure mechanical damage is likely to be extensive, and the solvent action of the organic fluids considerable.

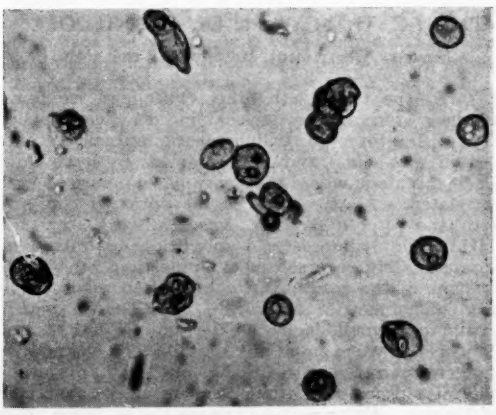
The technique that is being used in this laboratory has been developed primarily with onion roots. Tips about 5·0 mm. long are taken from vigorously growing roots. After excision the tips are transferred immediately to a 1·0 per cent solution (*p*H 6·6) of a commercial pectinase preparation, in which they are allowed to stand for three hours at 5·0° C. At the end of this period the material is transferred to a glass mortar in which it is ground lightly. The tissue breaks down rapidly, yielding a thick mush which is immediately suspended in a 1·0 per cent pectin solution. The suspension is filtered twice through a coarse sintered glass filter and finally centrifuged twice, as slowly as possible. A suspension is obtained in which the surfaces of many of the nuclei are apparently unbroken and completely free of adhering cytoplasmic fragments. The suspensions, however, are not free of cellular debris. They contain occasional fragments which limit the value of the preparations for cytochemical observations; but they are probably sufficiently clean to be used for cytological and some physiological purposes.

The pectinase treatment tends, of course, to disintegrate the wall and thus to facilitate the release of protoplast components. The separation of the nuclei from the cytoplasm is no doubt primarily simply a consequence of a loose connexion between these two components of the protoplast. At the same time, certain observations suggest that the enzyme preparation may have some effect on the cytoplasm itself. Although occasional nuclei may be obtained by grinding tissue without previous treatment, these are usually covered with a mantle of cytoplasmic threads. Further, prolonged treatment reduces markedly the yield of nuclei. It may be emphasized, however, that since the pectinase preparations used here undoubtedly contain a considerable proportion of impurities, the possibility cannot be disregarded that the apparent effect on the cytoplasm is due to substances other than the pectinase.

After grinding, the nuclei are dispersed in the fluid released from the tips. In this they remain intact for about an hour at room temperature. When they are transferred to water or to an inorganic salt solution they disintegrate immediately. Some nuclei survive for short periods in dilute solutions of citric acid. Many, however, do not, and those that do tend to have a granular abnormal appearance. It was thought in an early stage of the investigation that the possible effect of pectinase on the cytoplasm might be due to the disintegration of a polysaccharide which binds the nucleus to the cytoplasm and has a stabilizing effect on it. The effect of suspending the nuclei in a pectin solution was accordingly explored. It was found that a 1 per cent solution of a commercial pectin preparation sold for domestic jam-making preserved the nuclei for periods up to 9 hr. At the same time it was also found that a 1 per cent solution of bacteriological peptone gave the same result. Since pectin involves fewer complications than peptone, the use of a dilute solution of the former has been adopted as a standard procedure. It may be noted that the effects of pectin and peptone suggest that in the cell the stability of the interphase nucleus may be promoted by the action of certain polymers on the nuclear surface.

The filtration through sintered glass removes the bulk of the larger fragments, and the subsequent centrifugation the majority of the smaller. Slow centrifugation is important. With rapid centrifugation the nuclei tend to disintegrate into a thick, viscous mass which settles to the bottom of the tube. It has been found convenient to use a small hand-centrifuge for 6–7 minutes.

The rapid disintegration in water suggests that immediately after isolation the proteins of the nuclei are in an undenatured state. When any treatment is applied which tends to coagulate the proteins, then the nuclei remain completely stable in water. The suspensions that have so far been obtained consist almost entirely of interphase nuclei in which with normal visual light no structures other than nucleoli are discernible within them. The number of these



Isolated nuclei. × 500

varies between 1 and 4. A surface membrane cannot be identified either with the visual or the ultra-violet microscope. After isolation the nuclei behave as simple gels. They do not markedly contract or expand with changes in the osmotic pressure of the external fluid, which suggests that they do not contain a free liquid phase.

The variation within the suspension is large. The shape, optical properties and resistance to chemical treatment vary considerably. While most of the nuclei are circular in surface view, many are rod-shaped with rounded ends. Some are clear and translucent, whereas others appear to be more opaque. It appears to be the large translucent nuclei which are most unstable after isolation. Such variations are no doubt to be expected in a region such as the root tip in which the cells are in different stages of development, and in which those that are meristematic are in different phases of the division cycle.

Finally, although the technique described above has been developed with onion root tips, it has been shown that free nuclei may be obtained from root tips of other species, from mature regions of the root, and from immature leaves. From these other materials, however, suspensions relatively free from cellular components other than nuclei have not been obtained. With onion root tips the most satisfactory preparations have been obtained from young, vigorously growing roots.

The initial observation on which this work is based was made while I was a guest in the laboratory of Dr. V. M. Cutter, of the Osborn Botanical Laboratory of Yale University, and I wish to thank Dr. Cutter for his help at that time. I also have to acknowledge my indebtedness to Prof. I. Manton for considerable advice, and Mr. B. Clarke for taking the photograph which accompanies this article.

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PROPERTIES AND REACTIONS OF MIXTURES OF TRIFLUOROACETIC ANHYDRIDE AND OXY-ACIDS

By Dr. E. J. Bourne, Dr. J. E. B. Randles, Dr. J. C. Tatlow and Dr. J. M. Tedder

Chemistry Department, University, Birmingham 15

For some time, with other colleagues, we have been studying the physical and chemical properties of mixtures of trifluoroacetic anhydride and certain oxy-acids, and our observations have now reached a stage where they may be summarized and correlated. All the data so far obtained conform with the hypothesis that, when a weak oxy-acid (HOX) and trifluoroacetic anhydride are mixed in approximately equimolecular proportions, the main product of the reaction, which is often vigorous, is the 'unsymmetric' anhydride (CF_3COOX), which exists to a small degree as the ions CF_3COO^- and X^+, as is shown in equations 1 and 2. The alternative mode of ionization into CF_3CO^+ and OX^- is improbable, because of the strong electronegative character of fluorine. We propose to present the evidence upon which this hypothesis is based.

$$(CF_3CO)_2O + HOX \quad \rightleftarrows \quad CF_3COO^- + X^+ + CF_3COOH \quad (1)$$

$$CF_3COO^- + X^+ + CF_3COOH \quad \rightleftarrows \quad CF_3COOX + CF_3COOH \quad (2)$$

If the hypothesis be true, then a mixture of an oxy-acid (HOX) and trifluoroacetic anhydride should effect substitution by the reactive electrophilic X^+ ion. For example, when HOX is a carboxylic acid (RCOOH), the mixture should furnish a source of acylium (RCO^+) ions, and should be a powerful acylating, rather than trifluoroacetylating, medium. In conformity with this, we have already shown experimentally that such a mixture reacts readily with hydroxy-compounds to give esters of the carboxylic acid[1,2], and with activated aromatic compounds (for example, polyalkyl benzenes, phenyl ethers, furan and thiophen) to form the corresponding ketones[3]; in neither of these two types of reaction was the formation of the trifluoroacetyl derivative observed. In an analogous fashion, mixtures of sulphonic acids and trifluoroacetic anhydride have been employed for the preparation of sulphonate esters[2] and of sulphones[3].

The introduction of basic substances has a pronounced effect on the chemical reactions of carboxylic acid – trifluoroacetic anhydride mixtures. Thus, the introduction of sodium acetate into a mixture of acetic acid and trifluoroacetic anhydride greatly reduces the acetylating power of the medium, which then forms both the acetate and trifluoroacetate esters when it is allowed to react with an alcohol[4]. Likewise, the treatment of primary amines with acetic acid and trifluoroacetic anhydride affords mixtures of the acetyl and trifluoroacetyl derivatives in which the latter frequently predominate[5]. These observed effects of bases find a logical explanation in the above theory, for the introduction of a base into the system would be expected to increase markedly the concentration of the trifluoroacetate anion, which in turn would decrease the concentration of the reactive cation (CH_3CO^+ or X^+) in favour of the molecular anhydrides [$CH_3COOCOCF_3$ and $(CF_3CO)_2O$], both of which are capable of promoting trifluoroacetylation (compare Emery and Gold[6], who studied the reactions of unsymmetric anhydrides derived from acetic acid and chloroacetic acids). The fact that sodium trifluoroacetate itself, when introduced during an esterification process involving acetic acid and trifluoroacetic anhydride, similarly increases the trifluoroacetate/acetate ratio, lends support to these arguments[4].

Evidence of the validity of our hypothesis has been obtained also by physico-chemical methods. Cryoscopic data furnished by Morgan[7] revealed that, when trifluoroacetic anhydride is dissolved in a large excess of acetic acid, each anhydride molecule gives rise to two other molecules. His results eliminated the possibility that the reaction proceeded solely according to equation 3, which requires that each trifluoroacetic anhydride molecule should afford three other molecules, but they agree with equations 1 and 2 if it be assumed that the degree of ionization of the unsymmetric anhydride is very small. We have obtained proof, by measurements of electrical conductivities, that ions are formed in mixtures of acetic acid and trifluoroacetic anhydride. The addition of acetic acid to excess trifluoroacetic anhydride, and likewise the addition of trifluoroacetic anhydride to excess acetic acid, resulted in a

very marked rise in conductivity, which, although it still remained quite small, was much too large to be due to the trifluoroacetic acid formed according to equations 1 and 2, and was slightly greater than could be accounted for by the two molecules of acid formed as in equation 3.

$$(CF_3CO)_2O + 2CH_3COOH \rightleftharpoons (CH_3CO)_2O + 2CF_3COOH. \quad (3)$$

It should be noted that, for the acylation of hydroxy-compounds[8] and of anisole[9], the carboxylic acid – trifluoroacetic anhydride mixture may be replaced by one consisting of a carboxylic anhydride and trifluoroacetic acid. For use in a general method of acylation the latter mixture is less convenient, for it entails the preparation of each individual carboxylic anhydride; however, it does possess the advantage that a stoichiometric amount of trifluoroacetic acid is not required. As will be seen from equations 4 and 5, the trifluoroacetic acid which is utilized in the formation of the unsymmetric anhydride is regenerated when this anhydride reacts, for example, with an alcohol ($R'OH$). In support of the theory that the unsymmetric anhydride is an intermediate in this reaction, we have shown that aniline reacts with a mixture of acetic anhydride and trifluoroacetic acid to form both acetanilide and trifluoroacetanilide[5].

$$(RCO)_2O + CF_3COOH \rightleftharpoons RCO.O.COCF_3 + RCOOH. \quad (4)$$

$$RCO^+ + CF_3COO^- + R'OH \rightleftharpoons RCOOR' + CF_3COOH. \quad (5)$$

From the above evidence, it will be seen that there is strong factual support for our hypothesis concerning the mode of reaction between weak oxy-acids and trifluoroacetic anhydride. Since this support has been drawn from experiments in which the oxy-acid is of either the carboxylic or sulphonic type, it should not be assumed that other oxy-acids do not react in a similar fashion. Indeed, it has already been shown in these laboratories that trifluoroacetic anhydride promotes the formation of phosphate esters from phosphoric acid derivatives, of nitrate esters and nitro-compounds from nitric acid[8], and of nitro-compounds, nitroso-compounds and diazonium salts from sodium or amyl nitrites[8]. All these reactions, details of which will be published later, can be explained satisfactorily on the basis of equations 1 and 2.

We are greatly indebted to Prof. M. Stacey for his interest in this work, to Imperial Chemical Industries, Ltd. (General Chemicals Division), for part of the trifluoroacetic acid used, and to the Department of Scientific and Industrial Research for a grant towards the expenses. [June 26.

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THE ELECTRICAL RESEARCH ASSOCIATION

DURING October 10–12 the laboratories at Perivale of the Electrical Research Association were open for general inspection by some seven hundred members of the Association and others interested in its work, this being the first time they had been on view since the official opening by the late Duke of Kent in 1935. Some of the researches of the intervening years were exhibited, though the emphasis was naturally on current work. In view of the limited size of the Laboratories themselves and of the Association's income the range of exhibits was noteworthy, and the exhibition may be expected to expedite the provision of improved facilities in the Association's accommodation at Leatherhead.

Of necessity, the presentation conformed with the organization of the Association's researches into switch and control gear, surges and transformers, insulating materials, transmission and utilization, rural electrification and wind power, space and water heating, ignition and the welding arc. In addition, the important work carried out extra-murally on magnetic materials, power plant materials, meter bearings, and electrical discharges in gases was also displayed, though necessarily in a less complete manner.

A series of introductory displays were shown which aimed at summarizing aspects of the Association's work that cut across the organizational divisions. These dealt with the important parts played by the Association in the fields of national and international co-operation, standardization, and in the study and developments of materials (including a separate exhibit on electrical discharges in gases). Other displays outlined the contributions made in education, instrumentation, earthing and the application of mathematical methods, while another indicated the valuable facilities which the library and information bureau offers to members.

Switch and Control Gear. A striking exhibit in this field was a display illustrating the genesis, development and industrial applications of two basic principles of arc extinction, namely, the axial air-blast circuit-breaker with a short, fully scoured arc-gap and the oil-filled, side-blast baffle pot, which have formed the basis of nearly all modern switchgear development in Great Britain.

Most of the present work is of a fundamental character and was well illustrated by the demonstration of the oscilloscopic, stroboscopic and spectroscopic study of low-power arcs in hydrogen, which has clarified the phenomena observed at much higher powers, and by the photographic study of arc form and movement in an axial air-blast circuit-breaker. A semi-commercial axial gas-blast breaker is being used for studying the aerodynamics of arcs in high-speed gas flow, and *Schlieren* pictures of the shock waves in cold gas flow in a nozzle were demonstrated.

Since the electrical characteristics of the circuit of which the breaker forms a part influence its operation, another display illustrated the results of a survey of the restriking voltage characteristics of British high-voltage networks.

A bridge-connected fuse of novel design giving improved performance, and a miniature electromagnetic pressure-recorder were features of the fuses laboratory. Work on contactors, air-break switchgear and flameproof electrical gear was also displayed.

Surge Phenomena. The study of surge phenomena has, as its main objective, the increased reliability of overhead transmission systems during thunderstorms. The work includes the collection of data on the occurrence of thunderstorms, the correlation of these with data on lightning faults supplied by the area electricity boards, measurement of lightning currents, the effects of lightning on insulators and substation plant, and the study of all problems associated with methods of protecting against lightning.

Demonstrations included the calibration of magnetic links (surge current indicators), the distribution of various types of surge in transformer windings, detection of transformer faults due to surges, protection of a transformer by a surge filter, and the protection of a wooden stay insulator by an air gap. Most of the recording apparatus was designed and constructed by the Association, a notable example being an automatic, three-element oscillograph for continuous recording on lines operating at voltages up to 132 kV.

Transformers. The investigation in the Association of transformer problems, other than those associated with surge phenomena, is of comparatively recent growth, but already it includes transformer noise, the experimental investigation of mechanical forces, the general study of temperature distribution, the application of the capacitor transformer to the measurement of very high transmission voltages, and various problems associated with parasitic losses. Demonstrations included investigations of mechanical forces and of temperature distribution in experimental transformers.

Transmission and Utilization. The great use made nowadays of model and analogue techniques was illustrated by a pilot network analyser suitable for steady-state and transient solutions and incorporating novel features leading to low cost and versatility, and by a model high-voltage D.C. transmission system. This has yielded important information on starting, operation and protection, which will undoubtedly facilitate progress with a pilot full-scale project, when the necessary resources are marshalled.

A diagram entitled "Control of Radio Interference" summarized the work in a field in which the Association is widely recognized as an authority, and interference measuring sets and examples of suppression components were exhibited.

The detection of incipient failure in insulation provided an interesting example of the logical development of a method of assessment of a property not itself measurable, through the following stages: study of the material for the selection of an associated measurable property, construction of precise equipment for measurement in the laboratory, and, finally, reduction to a portable and simple instrument for field use.

The sensitive recording magnetometer, now used for measuring small changes in the earth's magnetic field to permit ionospheric predictions, is a modified form of the magnetic bomb and mine locator developed during the Second World War.

Dielectric Materials. The majority of the exhibits in the section on materials illustrated various mechanisms of electrical breakdown, a subject to which the Association has made very great contributions. Ionic discharge within voids in insulation were shown by an artificial transparent cable, with a series of oscillograms, electrophotographs and photomicrographs demonstrating the behaviour of the discharges and the nature of the microscopic breakdown paths which they erode in insulation.

Electrochemical reactions due to leakage currents through materials have only recently been recognized as an important factor in breakdown. Tests were in progress on insulation 'stabilized' against such reactions by the addition of hydrogen-accepting compounds. Other electrochemical work included a study of ionic exchange reactions in paper as a means of reducing its electrical conductivity, and an investigation of reactions in electrolytic capacitors. Several compounds were exhibited, including long-chain paraffins, alcohols and ketones, which had been synthesized in the laboratory in connexion with the foregoing, or for investigations on the relation between crystal structure and dielectric behaviour.

Notable in this section was the wide range of physical methods which can be adapted to the study of electric properties. These included the development of photographic emulsions by electrolysis for detecting minute faults in insulation; the polarizing microscope applied to the study of molecular orientation in polystyrene; a vacuum torsion balance accurate to 10^{-7} gm. in 0·1 gm. for the measurement of moisture sorption; X-ray diffraction as a means of identifying compounds or for following changes in their structure; apparatus giving hydrostatic pressures up to 1,000 atmospheres for the study of structural changes; and a high-temperature furnace adapted for single-crystal growth in connexion with the study of ferro-electric compounds.

Reports and published papers indicated the major contributions to the theory of the solid state (including a new theory of superconductivity) made by leading scientific workers in this sphere under the ægis of the Electrical Research Association.

Magnetic Materials. A selection from the large number of reports available illustrated the work done on sheet steel and permanent magnet materials. Important results were obtained from the work on sheet steel at Cambridge, now concluded, and its continuance on a larger scale is being considered. On permanent magnets, X-ray studies are being made at Cambridge with the fine-beam technique on precipitation states in iron–copper–nickel alloys and alloy phase structures. At Sheffield precipitation-hardening alloys of nickel, chromium, iron, etc., and the mechanism of hysteresis are being investigated. At Nottingham the Bitter powder technique is being applied to domain structure and formation, and was demonstrated on a magnetized crystal of cobalt. Co-operative research with member organizations of the Association on the commercial production of permanent-magnet materials, including crystals, has led to the development of magnetic bodies with remarkable properties.

Power-Plant Materials. To improve generating efficiency in steam power stations, higher temperatures and pressures are being used, and the Electrical Research Association, jointly with the British Iron and Steel Research Association, supports an extensive investigation at the National Physical Laboratory on the creep and corrosion resistance of steels under these conditions. Corresponding extensions of the steam tables are naturally essential, and the Electrical Research Association, having sponsored the development of the Callendar tables from the start, has put in hand a further extension. The general nature and results of this work were illustrated by diagrams and specimens. It has been estimated that, as a result of twenty years of research and development, the increased efficiency of generation results in an annual saving of 18·5 million tons of coal.

Rural Electrification. Practical, rather than fundamental, problems are met with in the applications of electricity to agriculture, stress being placed always on the attainment of low electric loading and high load factor. The exhibits demonstrated how these essentially economic aims have been achieved in various aspects of soil- and space-heating and crop-drying by electrical methods.

Electric Power from the Wind. Photographs illustrated the type of hill usually found suitable for wind-power sites, on which studies of wind regime and wind structure have been made. The model wind-generators exhibited included one of the 100-kW. pilot plant now erected on Costa Hill, on the Orkney mainland.

Space- and Water-Heating. The work deals with the fundamental side of problems arising from the use of electricity for space- and water-heating, mainly from the domestic aspect. The major current research is an all-round study of the heat pump. One small installation using static water as a heat source is in operation at Perivale, and other work on heat sources such as the earth is in progress. A model house was on show which could be operated to show the possible saving effected during transient warming periods by the use of reflecting wall papers.

Ignition Research. Investigations on the electrical equipment of vehicles, including novel types of sparking plugs and the suppression of radio interference, constituted an important contribution to the national effort during the Second World War, and this work has continued with the support of the Ministry of Supply. A major aspect is the study of ignition by electric sparks, and this is also of considerable interest to the Safety in Mines Research Establishment of the Ministry of Fuel and Power, which maintains close liaison with the Association.

A high-speed single-transient oscillograph, giving a temporal resolution of 10^{-9} sec., has been developed by the Association for these researches and is being extensively used.

The Welding Arc. The detailed investigation of ferrous welding arcs was recently interrupted so that a study might be made of A.C. argonarc welding of non-ferrous metals. The result has been the development of a surge injector which maintains the arc with an A.C. r.m.s. voltage of less than 50, and is free from radio interference.

RHEOLOGY OF FILMS AND SURFACES

THE annual conference of the British Society of Rheology was held jointly with the local section of the Chemical Society at the Washington Singer Laboratories of the University College of the South-West of England, Exeter, during September 27–29. The conference was opened by Prof. H. T. S. Britton and by Dr. G. W. Scott Blair, president of the Society. On the afternoon of September 28 a visit was arranged to St. Mary's Abbey, Buckfast, when Brother Adam demonstrated the thixotropic breakdown and other rheological properties of honey in production processes. Papers were read by B. A. Pethica and by J. H. Schulman and M. Z. Dogan (Department of Colloid Science, Cambridge) dealing with the properties of insoluble monolayers at an air/water interface in the presence of some soluble long-chain electrolytes of strong activity. Comparison of the Langmuir isotherms for penetration of liquid-condensed chloresterol with a series of straight-chain C_{12} compounds has shown that the polar head group specificity falls off in the order:

$$SO_4^- > SO_3^- > NH_3^- > COO^+ > NMe_3^+.$$

In the case of the interaction of saponin with condensed chloresterol, where a stoichiometric complex is formed, the penetration isotherm shows a transition corresponding to the formation of a two-dimensional solid film. The areas of the saponin show a corresponding change in the transition zone.

Studies have also been made of the penetration of myristic acid by dodecylamine hydrochloride and of the properties of protein films in the presence of electrolytes in relation to the tanning industry. Prof. F. H. Garner and Dr. C. W. Nutt (Department of Chemical Engineering, Birmingham) read a paper on cybotactic phenomena at interfaces, describing experiments on the movement of droplets in viscous media. Evidence on the molecular orientation into a quasi-crystalline structure was discussed in its relation to chemical engineering phenomena, for example, mass transfer across interfaces.

E. Eisma (Netherlands) described experiments on the rheological properties of interfacial films on water. For films of high yield-stress and small viscosity the rotating disk method is suitable, while in the case of purely viscous interfaces the torsion oscillation method has an advantage.

Under the chairmanship of Prof. M. Reiner (Haifa), K. V. Shooter (Research Laboratory for the Physics and Chemistry of Surfaces, Cambridge) described the mechanism of boundary lubrication at light loads taking into account the pressure-dependence of viscosity of oil films. H. J. Bezer and Dr. R. Schnurman (Manchester Oil Refinery) discussed experiments with extreme-pressure lubricants using a four-ball apparatus of the Boerlage type. There was no evidence for a defined 'breakdown load' of a lubricant. An energy balance would appear to allow for an appreciable proportion, up to 10 per cent, of the mechanical energy to be available for the separation of electrostatic charges.

At another session, with Dr. R. N. Saal (Netherlands) in the chair, C. C. Mill (Printing and Allied Trades Research Association) spoke on the rheology of printing, mainly of letterpress and lithographic processes, the photogravure process being fundamentally different and generally simpler rheologically. There was a discussion on the significance of the phenomenon of parallel ridge formation in the ink film on rotating rollers in contact. M. R. Hopkins (British Iron and Steel Research Association) spoke on the mechanics of the coating of steel sheet with molten tin between rollers. A mathematical investigation based on arguments similar to those used in the theory of lubrication gives a relation between the coating thickness and the relevant variables for a single pair of rollers. This relation was found to be in accord with experimental results obtained with a sheet of nickel foil emerging from a bath of oil through a pair of polished stainless-steel rollers under precise conditions of test. A. de Wael and G. L. Lewis (Gestetner) read a paper on the electrical behaviour of oil-pigment dispersions. They have found that a dispersion with electrically conducting particles behaves differently according to the state of flocculation, whereas with non-conducting particles there is little difference. Conductive systems do not seem to obey Ohm's law. It is possible to correlate the

electrical with the rheological behaviour. Materials exhibiting dilatancy—for example, titanium oxide in liquid paraffin—increase in conductivity during shear and rapidly decrease to a constant value on arrest of shear. In strong deflocculating media, such as carbon black in polymerized linseed oil, the dispersions with high yield values show neither conductivity nor high dielectric constant.

D. W. Jopling (Kodak, Ltd.) described apparatus with a servo-mechanism, designed to measure the rate of radial flow of a liquid between parallel surfaces, for the purpose of ascertaining the rate of swelling of colloidal films. The swelling of a film on one of the parallel surfaces alters the rate of flow between the plates, making it possible to calculate the increased thickness. E. Bielak and Dr. E. W. J. Mardles (Royal Aircraft Establishment), in a paper on the flow of liquid films over solids, reported that from experiments on the flow of drops along inclined planes and through capillaries, and on the radial spread of liquid pools over and between surfaces, anomalous flow-rates have been found. The flow behaviour over any one surface varies considerably with the chemical character of the liquid. Between surfaces, with films of thickness less than 10 μ, there is a tendency for the film to disrupt with the formation of pin holes and with a consequent onset of film plasticity and thixotropy, noted by earlier investigators with lubricants. This phenomenon appears to be significant in relation to the 'wringing' together of flats, hydraulic 'stiction' and the development of rigidity in lubricant films. E. W. J. Mardles

MARINE BIOLOGICAL STATION ON INHACA ISLAND, MOZAMBIQUE

By Mrs. OLIVE S. TATTERSALL

For several years certain biologists in South Africa have realized that the waters in and around Delagoa Bay are particularly favourable for work in marine biology. In spite of many difficulties, parties of students with the late Prof. C. J. van der Horst, of the University of the Witwatersrand, have paid regular visits to this area and have explored its varied collecting grounds. They found that there are particularly good centres for work along the western shores of Inhaca Island, which forms part of the eastern boundary of Delagoa Bay. There they worked under considerable difficulties, camping out on the foreshore in great heat, preyed upon by mosquitoes and working with inadequate and improvised apparatus. To-day, thanks to the generosity and sympathetic co-operation of the Government of Mozambique and to the enthusiasm of Prof. van der Horst, a remarkably fine biological station has been built on Inhaca Island.

In the early part of this year I was able to spend a few weeks working at this Station. On arrival at Lourenço Marques a small tug-boat was placed at my disposal by the Department of Maritime Services, and at 5 a.m. we left for the Island, 22 miles due east of the city. As we approached, the Island looked flat and uninteresting, and it was not until we were almost at the shore that the few native huts of the fishing village on the north-west coast of Inhaca appeared nestling at the foot of the low hills which rise close to the shore. We then turned south for about three miles when, on rounding a rocky promontory, we saw, on a flat stretch of dazzling white sand, three low white modern buildings, looking startlingly out of place in this scene which appeared never to have been touched by Western civilization.

Although there are more than four thousand Africans living on the Island, there is not a trace of any human habitation as one approaches from the sea. For the most part the western shores facing on Delagoa Bay have a short foreshore with low hills rising sharply as steep cliffs, densely covered with tropical vegetation. The site chosen for the Biological Station has a wider foreshore, and the hills behind it rise less steeply, though they are near enough to afford shelter from the east.

The Station consists of three detached buildings, connected by a paved causeway: the laboratory, with a wide shady veranda specially designed to meet the climatic conditions; the refectory, with kitchen, storehouses, dining-room and a wide veranda: and the dormitory, with comfortable cool rooms, modern sanitation, running water, shower baths and most appropriate modern furniture. The buildings are thoroughly mosquito-proofed so that one may enjoy the cool of the evenings in comfort. The whole of the cost of the buildings, water, electricity and sanitation has been borne by the Government of Mozambique, while the scientific equipment and furnishing has been provided by the University of the Witwatersrand.

Delagoa Bay is for the most part very shallow, though there are deep channels which will yield rich harvests to the dredge, and large sandbanks are exposed at low water. Here, among the weed and coral, one can find the utmost profusion of marine life—ascidians and sponges of the most wonderful colours, delicate planarians, sea anemones, nudibranchs, echinoderms and many worms and crustaceans.

The shore off the Station slowly shelves, and the sea goes out for a very great distance at low water. Then beyond the low-water level, for an equally long distance, there is water of not more than a foot in depth, so that good collecting is available at practically all stages of the tide. The littoral fauna is particularly rich, and my only regret was that I knew so little of it and that there were not enough books to enable me to identify the animals I found. It will, of course, be years before one can expect to build up an adequate library to cope with such abundance of life. In the meantime, I can imagine no finer holiday than a few weeks spent here, away from all the turmoil of the modern world, in a realm of Nature which man has not yet spoilt. Every possible facility is given by the Portuguese authorities to workers, and it is most refreshing to find such a sympathetic attitude existing in which the scientific investigator is allowed to work for the love of the work and is not hampered by the knowledge that he has to produce results at all costs. Although Inhaca may appear to be very remote, it is actually quite easy of access. The Union Castle ships call weekly at Lourenço Marques, and transport from the city to the Island is generously provided free of cost to the scientific worker by the Captain of the Port at Lourenço Marques. Fishing-boats pass daily between the Island and Lourenço Marques, and the Africans are always willing to bring goods from the mainland and to supply food cheaply.

I had no experience of dredging, for facilities for this type of collecting are not yet available; but nets are being bought, and it is hoped that before long a

suitable boat will be attached to the Station to make their use possible. Judging by the shore fauna, there is no doubt that the dredge will reveal as rich a bottom fauna as any biologist could desire. The real industry of the Island is fishing, and it is an experience never to be forgotten to watch the small boats gathering at about 4 p.m. each evening off Inhaca village and transferring their day's catch to the larger boats, which will sail all through the night to deliver it in time for the early morning markets in Lourenço Marques. Many an interesting fish or other animal can be 'collected' by the biologist at these evening gatherings.

It is a brave venture to have established so fine a station in this spot, and it is to be hoped that many workers will be able to avail themselves of the unique opportunities for research which it affords.

THE BRITISH COUNCIL

REPORT FOR 1950–51

IN the annual report of the British Council for 1950–51*, which covers the year ended March 31, 1951, the general plan is that adopted for the first time in last year's report, though some of the chapter headings are different and that on the Council and the sciences disappears. A series of eleven chapters reviews in general terms the work of the Council in promoting cultural relations in four main territorial regions—Latin America, the Middle East, the Far East and the Commonwealth—then the work of the institutes, advisory visits abroad, work in the United Kingdom for the welfare of overseas students, and, finally, finance. Detail for the most part is given in a series of appendixes which occupy roughly half the report, of which those dealing with university interchange, lecturers overseas, and courses organized by the Council are of chief interest to the scientific worker.

In view of the publicity which the closing of three hostels for overseas students in Britain has received during the year, the section of the report which deals with the welfare of overseas students will be read with special interest. The scheme which the Council prepared, in consultation with the government departments concerned, for covering its wider responsibilities for the welfare of Colonial and overseas students generally for the period January 1, 1950, to March 31, 1954, was based on the view that, since it is undesirable to segregate Colonial students, hostels should not, if it could be avoided, be used by Colonial students only; and that, ideally, hostel accommodation should be regarded as a temporary necessity and that accommodation should be found for as many as possible either in permanent halls of residence, or with private families or in lodgings. Where hostel accommodation was unavoidable, it should be of a standard comparable with that of a university hall of residence.

The three hostels were closed in accordance with this policy and replaced by one residence housing 200 men, which was opened in Hans Crescent, London, in October. Planned and equipped to the standard of a modern university hall of residence, this is intended also to become a live centre for the Colonial student population of London. Those selected to spend a year there were mainly freshmen. A hostel in Edinburgh for twenty-eight men was taken over from the Colonial Office, and one for twenty-five men was re-opened in Newcastle. The small hostels in Manchester and Leeds had been established before the Council assumed its new responsibilities from the Colonial Office, and were not a part of the Colonial student welfare scheme. As a measure of economy, arrangements had to be made to close them at the end of the year; but the Leeds hostel was reprieved later through private generosity. Most Colonial students have to be accommodated in private houses, and the finding of suitable billets has not been easy. The report states that by the end of the year it was clear that additional hostel accommodation is required in London. The report stresses the value and far-reaching effects of this work; but points out that what really matters is how much the British public can be stimulated to do for such students.

Other work in the United Kingdom of particular interest to the scientific world is that of the Students Department, where the awards were re-distributed in view of the withdrawal of the Council from work in Czechoslovakia, Hungary and Bulgaria and the cessation of the flow of scholars from China. The number of scholarships for Germany and Yugoslavia was increased, and students from Burma, Indonesia and Thailand partly offset the loss of Chinese scholars. In October 1950 scholars came for the first time from India and Pakistan, the demand from India being such that for the present the field is to be restricted to candidates holding first-class honours degrees and who are to study education and public administration. In general, the proportion of applicants offering the sciences, notably medicine, economics and agriculture, is increasing. The number of bursaries, which provide opportunity for short-term intensive study in industry or the professions, was increased from 125 to 197, more than two-thirds being drawn from industry, agriculture and the social services. Five tours were organized for Greek provincial governors for the study of local government administration. New commitments in the Fellowships Section of the Visitors Department, which deals with all fellowships awarded for study in the United Kingdom by the United Nations and its Specialized Agencies, are in connexion with the International Labour Office Fellows and technical students under the Colombo Plan. Of the visitors, 258 were concerned with the social sciences, which displaced medicine (191) as the principal interest, education (147) coming third.

Departments constituting the Science Group further scientific exchanges with other countries, and as a result of last year's visit to Great Britain of the Secretary-General of the Spanish Higher Council for Scientific Research, several Spanish science students have received training in Britain and a delegation of British scientific workers attended the Higher Council's tenth annual congress at Madrid. The correction of the texts of Scandinavian scientific papers for publication in English continued on an increasing scale, and the Medical Department alone handled some sixteen hundred miscellaneous inquiries. The *British Medical Bulletin* continues to be the most successful scientific publication of the Council, and the monthly *British Medical Book List* has been launched to meet the overseas demand for a comprehensive list of this kind. In view of a comment by the Select Committee on Estimates, the size of the staff employed in the United Kingdom by the Council has been investigated by the Organization and Methods Division of the Treasury, as part of a wider inquiry into the

* Report on the Work of the British Council for the Year ended 31st March, 1951. Pp. v+120. (London: British Council, 1951.)

Council's organization and methods which lasted nearly two years. Only in the clerical and typing grades were any posts considered redundant by the investigators.

Besides the withdrawal from Czechoslovakia and Bulgaria, the feature of the Council's work in Europe during 1950–51 was the opening of a new branch in Düsseldorf to take over the work previously done by the cultural department of the High Commission in Germany. The European work bore a major share of the reduction made in the Council's grant-in-aid as a whole, and the European budget for 1950–51 was about £100,000 less than that for the previous year. With Latin America this budget still accounts for more than half the Council's expenditure on overseas services, though expenditure in the Middle East comes next to that in Europe in magnitude. Lack of funds compelled withdrawal from the Sudan. Outside education in its narrower sense, the report suggests that the bringing of specialists and influential visitors to Great Britain and the giving of lectures, with supporting illustrative material, on agriculture and its associated sciences are the best means of maintaining and strengthening the interest of the Middle Eastern countries in the culture and institutions of the United Kingdom. In the Far East, with the exception of China, where a marked increase in the work of the local centres at Nanking, Shanghai and Peking was noted during the year in spite of Government interference with the Council's work, the main difficulty has been lack of funds; but as regards Latin America, commenting on the value of British publications for the propagation of knowledge, the report observes that in some countries currency restrictions or complicated import requirements constitute the chief obstacle and one which the Council can do little to overcome.

The British Council is responsible for the operation of schemes for the interchange of university teachers, scholars and scientific workers under the cultural conventions into which Great Britain has entered. Thirty-nine regular interchange visits of this type are already arranged each year with Austria, Belgium, France, Italy, the Netherlands and Norway. Negotiations are proceeding with Denmark, Western Germany, Spain, Sweden and Switzerland, which would bring the total to fifty-two, while under a scheme established at the request of the Conference of the Universities of the British Commonwealth at Oxford in 1948, thirty-three university teachers from eighteen Commonwealth universities visited the United Kingdom and one scholar from Britain visited Commonwealth universities. Seventy-two scholarships were offered to British students by Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Persia, Portugal, Spain, Sweden and Switzerland, in return for the scholarships offered by the Council for many years to students from foreign universities. The number of advisory visits has also increased, and the report cites in illustration those to France on recent developments in stock-breeding; and visits of a team of three surgeons, led by Mr. C. Price Thomas, to Yugoslavia; of Dame Katharine Watt to India, Pakistan, Syria, Egypt, Iraq, Jordan and the Lebanon, to advise on nursing services; and of Dr. Mouat Jones to the Middle East and India, to advise on the development of technical education.

The net expenditure of the Council during 1949–50, the last year for which figures of actual expenditure are available, was £3,045,321, and the total sum available from public funds for 1950–51 was £3,233,700. There were, however, considerable changes in the distribution of expenditure, the estimates providing for major expansions in the work carried out for the Colonial Office, the Commonwealth Relations Office and Colonial Development and Welfare, and for a contraction, under instructions, of the provision for work in foreign countries of £325,000; the devaluation of sterling added a further £206,000 to this last figure. In the estimates for 1951–52, the Council has been called upon to reduce the provision for work in foreign countries by a further £364,000, although the Foreign Office is pressing for the expenditure of £49,000 on new services regarded as of the highest importance. Such reductions must entail drastic changes, and it is a matter for regret that neither in this report nor elsewhere is there any indication of a real inquiry into how far there is overlapping in the work of the British Council with that of the Central Office of Information, the Foreign Office itself, and the Overseas Service of the British Broadcasting Corporation which could be eliminated to the general advantage.

ELECTRONICS IN NUCLEAR SCIENCE AND ENGINEERING

MANY visitors from overseas have been attracted to Great Britain in this Festival Year, not only to attend the Festival, but also to participate in the various supporting conferences arranged by the professional, scientific and technical institutes. The British Institution of Radio Engineers, the silver jubilee of which was to have been held last year, delayed its celebrations of this event and planned instead a Radio Convention for 1951. The Council of the Institution considered it appropriate that the Convention should aim at covering the whole field of electronics. In fact, the conference was probably the most comprehensive in its field ever to be held in Great Britain, and more than seventy papers were presented covering applications of electronics in all fields from nuclear physics to audio-frequency engineering. All the papers are being published in the *Journal* of the Institution.

The first session of the Convention was held at University College, London, during July 3 and 4 and dealt with the applications of electronics in nuclear science and engineering. The chair at these meetings was taken by Dr. Denis Taylor, of the Atomic Energy Research Establishment, Harwell, and his address, which was illustrated by lantern slides and cine-film, was a survey of the radiation and particle detectors used in modern nucleonic instruments. The paper included a discussion of the long-term stability of the detectors used in assay and other instruments, and summarized from this point of view the relative advantages and disadvantages of Geiger–Müller counters, proportional counters and scintillation counters. In particular, the paper gave consideration to the problem of industrial instrumentation where high reliability is the first consideration. Graphs were presented showing the changes of counting efficiency of typical Geiger–Müller counters over a period of time, and it was noted that with counters filled with argon and ethyl alcohol large changes in the efficiency can occur during their working life. Some

of these changes are related to photoelectric effects of the counter, variations of temperature, electrostatic effects on the window of the counter, etc.; but it was pointed out that, even when proper precautions are taken to avoid variations in the measured counting-rate due to all these effects, some fluctuations in the counting-rate outside those to be expected on statistical grounds are still obtained.

Dr. Taylor showed some typical curves for a Geiger–Müller counter and, in the cases shown, the counting-rate dropped by about 5 per cent in the first few minutes of use and then fluctuated over narrower limits during the course of the next hundred hours or more, the fluctuations being much larger than would be expected from the statistics. He pointed out that in laboratory experiments it is always possible to wait until the counter has settled down, and it is usually possible to determine the counting-rate of the unknown and a standard source and express the first result in terms of the second. This course allows all but the short-term variations to be eliminated, and very accurate measurements can then be made. However, in many instruments this second measurement with a standard leads to considerable complication and, in the case of industrial instrumentation, it is desirable to use more stable detecting elements both on the grounds of reliability and on the grounds of time-saving. Dr. Taylor showed graphs which indicate that Geiger–Müller counters using bromine as the quenching agent give an improved performance from this point of view, but that still better results can be obtained by using a counter operating in the proportional region, and he showed an apparatus of this type capable of giving a precision of measurement of $\pm$ 0·1 per cent and suitable for adaptation as an industrial instrument.

The two following papers were presented by K. Fearnside and Dr. J. E. Johnston, respectively, and dealt with various aspects of the use of radioactive tracers in industry. Mr. Fearnside reviewed the development of the beta-ray thickness gauge and described a number of preferred designs, dealing not only with the transmission gauge, but also with the back-scattering type. He gave details of the applications of these gauges in industrial work and information about their reliability and accuracy. It appears that they are already being used on a large scale, but that the obvious step of controlling the manufacturing process by a servo-mechanism operating directly from the gauge still remains to be done. The gauges in use at the present time simply measure the thickness of the manufactured material (strictly speaking, the mass per unit area, which is usually proportional to the thickness), and an attendant must make the necessary alterations to the machine if the thickness is outside the prescribed limits.

Dr. Johnston's paper covered a very wide field of applications, and the discussion which followed was equally wide. The main applications discussed were: determination of the presence of arsenic impurity in the germanium used for making crystal diodes (Dr. E. Billig, of the Laboratory of the Associated Electrical Industries, Ltd.); determination of the rate of wear of the dies used for making wire (Dr. J. W. Drinkwater, of the Thornton Research Centre); testing the uniformity of mixed cattle foods (British Oil and Cake Mills); testing the ventilation system of a factory (British Belting and Asbestos, Ltd.); and measuring the rate of wear of blast furnace linings (Mr. E. W. Voice, of the British Iron and Steel Research Association).

One of the most interesting papers presented at the conference was on the subject of the self-balancing potentiometric recorder. This instrument has proved to be one of great versatility and importance, and R. S. Medlock and W. A. Kealy in their paper gave a comprehensive review of the applications of this type of instrument in research and in industrial measurements. A large proportion of the applications discussed were those which have been developed for use in atomic energy plants—a novel example being the measurement of pile power. It is interesting to note that the self-balancing potentiometric recorder competes in many cases with the more orthodox instruments depending on the use of thermionic valve circuits, and for certain classes of problem offers a simpler and more satisfactory solution; moreover, in many cases the completed instrument is more compact.

The remaining three papers dealt more particularly with design of nucleonic instruments and were as follows: "Counting of Random Pulses," by E. H. Cooke-Yarborough; "Design of Portable Beta- and Gamma- Measuring Instruments," by E. Franklin and J. Hardwick; and "Pulse Circuits for the Millimicrosecond Range," by F. H. Wells. The paper on portable measuring instruments contained a great deal of new design data, and included details, to mention just a few of the novel ideas presented, of the use of cold-cathode valves in place of filament valves in these instruments, the replacement of the battery by a clockwork-driven electric generator, the replacement of the meter presentation system by a 'fluid light' type of indicator, and the use of infinite-life Geiger counter tubes. The majority of the instruments described were designed for use in the nuclear physics laboratory, or for field use by geologists or mining engineers, but some of the designs would be suitable for use by the civil defence authorities in the event of atomic warfare.

The paper by Mr. Wells dealt with a subject of more general interest, and gave a review of the circuit techniques used in measurements on short pulses and time intervals between pulses in the range $10^{-9} - 10^{-7}$ sec. The circuits described have been developed for use with scintillation and spark counters, and include pulse-shaping circuits, pulse generators, amplifiers, scaling circuits and oscilloscopes; and Mr. Wells gave examples of the use of these circuits for high-speed coincidence measurements, millimicrosecond time-interval measurements and fast counting. Probably the most interesting of the many circuits described is the fast coincidence circuit. This is essentially a mixer circuit, which will accept a pulse from each of two input channels and, if these pulses arrive at the same time, or within a given short time interval of each other, will give an output signal. In Mr. Wells's instrument the two input pulses are first shaped to give voltage impulses of defined duration, and these pulses are amplified so that each output pulse is of 10 V. amplitude. If, therefore, pulses from the two input channels arrive at exactly the same time, a double-amplitude pulse of 20 V. will be obtained. Hence, coincident pulses may be sorted out from non-coincident pulses by the use of a pulse-amplitude discriminator set to 15 V. following the amplifier, the output of the amplifier being the coincidence unit output-pulse. Mr. Wells gave details of a number of circuits he has built making use of this principle, and reported that the minimum coincidence resolving time readily obtainable is 10 millimicroseconds.

DENIS TAYLOR

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Protein Synthesis in Nucleated and Non-nucleated Halves of *Acetabularia mediterranea* studied with Carbon-14 Dioxide

It is generally assumed, after Caspersson[1], that the nucleus is the main centre of protein synthesis in the cell. However, this opinion is based on cytochemical and biological observations only (for example, the incapacity for sustained regeneration in many unicellular organisms), and it appeared desirable to test this assumption on biochemical grounds also.

An especially well-suited material has been found in the giant unicellular alga *Acetabularia mediterranea*, which has been extensively studied by Hämmerling[2]. The algæ were collected at the marine laboratory of Villefranche-sur-Mer, thanks to the kindness of Prof. Tregouboff, and they were grown according to Hämmerling's technique. Our biological observations concerning the extensive capacity for regeneration of nucleated fragments entirely confirm Hämmerling's; non-nucleated fragments of this alga are also able to initiate regeneration and even the formation of an umbrella. However, as Hämmerling has rightly noted, it is not easy to decide whether this corresponds to a real synthesis or to a mere elongation, due, for example, to a change in hydration.

In order to clear up this point, we carried out the following experiment: 50–100 nucleated and as many non-nucleated fragments, carefully washed and cleaned by means of a small paint-brush, were put into 12 c.c. of sterile medium (Hämmerling's) in a 50 c.c. Erlenmeyer flask; 2–4 mgm. radioactive barium carbonate (containing 1–2 μcuries of carbon-14) were placed in a small vial hanging from the stopper; radioactive carbon dioxide was liberated by adding a few drops of perchloric acid to the barium carbonate and the flask was immediately closed. The fragments thus kept in the presence of carbon-14 dioxide were exposed to the light of two 40-watt fluorescent tubes at a distance of 50 cm. After 24–38 hr., the fragments were rapidly washed free of radioactive medium, and sorted out (nucleated and non-nucleated fragments are readily distinguished, for the nucleus is located in the rhizoids of the alga).

The two groups of fragments were ground in 10 per cent trichloracetic acid in a small homogenizer, the insoluble substances were washed once with trichloracetic acid, and then hydrolysed for 18 hr. at 145° in 6 *N* hydrochloric acid, in sealed tubes. The amino-acids resulting from the hydrolysis of the proteins were decarboxylated with ninhydrin according to Van Slyke[3]; the carbon dioxide liberated was trapped in sodium hydroxide, then precipitated as barium carbonate, the specific radioactivity of which was determined by means of a thin-window counter.

The results of such experiments, performed with different batches of algæ that have been studied at different times after sectioning into two fragments, are given in the accompanying table.

Preliminary experiments had shown that the incorporation of carbon-14 dioxide into the carboxyl groups of the amino-acids is linear for at least 48 hr.; it seems thus that we are very probably dealing with a real protein synthesis. It might be added that control experiments have conclusively shown that the whole of the carbon dioxide liberated by ninhydrin really came from protein amino-acids and that the contribution in this process of contaminating organisms is negligible.

Time since sectioning	Time of CO_2 incorporation	Specific activity of CO_2 groups of proteins / Specific activity of CO_2 in the medium × 100		Specific activity of non-nucleated fragments / Specific activity of nucleated fragments
		Nucleated	Non-nucleated	
9 days	38 hr.	8·6	8·7	1·01
11 „	26 „	6·4	6·5	1·02
16 „	24 „	8·3	7·6	0·92
23 „	24 „	7·2	4·4	0·61
33 „	24 „	4·1	3·2	0·78
38 „	27 „	4·5	3·1	
		4·8	2·9	0·70

In conclusion, it can be advanced that, contrary to the generally accepted views, but in harmony with Hämmerling's biological observations, the presence of the nucleus is not necessary for protein synthesis to continue for a considerable time. It is not until two weeks after enucleation that incorporation of carbon dioxide in the protein begins to drop; but even after more than five weeks this incorporation is very far from negligible. The fact that according to London, Shemin and Rittenberg[4] hæmin synthesis takes place in reticulocytes (that is, basophilic non-nucleated erythrocytes) and that the same is probably true for globin and other proteins (Borsook *et al.*[5]) suggests that our conclusions are probably also valid for animal cells without photosynthetic activity. Our results agree also with those of Hultin[6], Keller[7], Siekewitz and Zamecnik[8], according to which cytoplasmic microsomes rich in ribonucleic acid show the highest rate of incorporation of labelled amino-acids into proteins of all cellular fractions obtainable by differential centrifugation, including nuclei.

J. Brachet
H. Chantrenne

Laboratoire de Morphologie animale,
Faculté des Sciences,
Université libre de Bruxelles.

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A Technique for taking Successive Shadowgraphs of Oat Seedlings

Owing to the great variability in growth-rate and tropic curvature of the coleoptile shown by oat (*Avena*) seedlings similarly treated, it is for many experimental purposes desirable to be able to take successive measurements of growth or curvature on the same individuals rather than on a fresh sample each time. Thus in experiments involving curvatures, in view of the difficulty in obtaining really straight seedlings to start with, doubtless partly due to nutation[1], it is most desirable to have initial records before treatment; it may also be useful to record the degree and kind of curvature at successive intervals after

stimulation or application of growth substance. This is, however, unsafe with the usual technique, in which the shadowgraphs are taken with white light, since the exposure itself induces curvature. Schneider and Went[1] therefore constructed their ingenious "photokymograph"; but this is only suitable for *decapitated* coleoptiles and for curvature but not growth measurements: it is, moreover, somewhat elaborate for routine or class use. The essence of the present technique is simply to use more-or-less panchromatic photographic paper for the successive shadowgraphs, and to make the exposures with light passed through an orange or red filter such that no phototropic or growth response can be detected even when the photographically necessary exposure is multiplied many times. These requirements have been met by the use of Kodak RP 15 "Reflex" paper and light from a tungsten filament lamp passed through a single layer of 'Chromex 2202/C10' orange cellulose acetate filter which has a cut-off at about 0·530 μ wave-length and a high transmission throughout the red. With a total intensity, at the position occupied by the seedlings, of 0·08 foot-candles, adequate shadowgraphs can be obtained with one minute's exposure. One hour's exposure of intact seedlings under these conditions has been found to cause no detectable growth response or subsequent curvature. It should therefore be safe to take a long series of successive records of the same seedlings.

With a double layer of the somewhat more red filter, 'Chromex 2436/C10', giving a cut-off at about 0·580 μ, and the somewhat higher total intensity of 0·48 foot-candles, an hour's exposure was found in one experiment to cause a slight but definite subsequent phototropic response. This indicates the importance of specifying not merely the colour but also the intensity and duration of the illumination in coleoptile experiments, a matter which is often overlooked; and it may, in fact, be doubted whether any wave-length in the visible spectrum is entirely inactive in affecting the growth and tropic curvature of the *Avena* seedling[2].

All the above results are for seedlings grown in deep red light (wave-length $> 0{\cdot}63\,\mu$, total intensity about 0·17 foot-candles) and it must not be assumed that the technique developed would be safe for seedlings grown in complete darkness.

Full details of this work will be published elsewhere.

O. V. S. Heath
Research Institute of Plant Physiology,
Imperial College, London, S.W.7.
Oct. 24.

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Iron/Sulphide Ratios in Corrosion by Sulphate-reducing Bacteria

The stimulation of iron corrosion under anaerobic conditions by *Vibrio desulfuricans* is well known, and the organism has recently been shown[1] to be a facultative autotroph. Several laboratory investigations of this type of corrosion have been described[2–4]. But, to our knowledge, there has, as yet, been no published comparison of the corrosion under heterotrophic and under autotrophic conditions. We have felt that such a comparison should throw further light on the mechanism of this type of corrosion and on the explanation first proposed by von Wolzogen Kuhr[3]. This worker considered that the stimulation of corrosion was due to the utilization by the bacteria of cathodically produced hydrogen, by which the corrosion reaction would otherwise be polarized.

$$4Fe + 8H^+ \rightarrow 4Fe^{++} + 8H \quad \text{(corrosion)}$$
$$8H + SO_4'' \rightarrow 4H_2O + S'' \quad \text{(bacteria)}$$
$$Fe^{++} + S'' \rightarrow FeS.$$

From these equations von Wolzogen Kuhr showed that, if no organic hydrogen donors were present and the hydrogen for sulphate reduction came solely from iron corrosion, then the ratio $\frac{\text{total Fe corroded}}{\text{Fe present as FeS}}$ should have a value of 4. This ratio is closely related to the ratio

$$N = \frac{\text{gm. atoms Fe corroded}}{\text{mol. } SO_4'' \text{ reduced}},$$

and this, as may be seen from the equations, should also have a value of 4, if von Wolzogen Kuhr's mechanism is correct and if no organic hydrogen donors are present. The presence of such hydrogen donors, as in heterotrophic medium, should result in additional reduction of sulphate, not accompanied by corrosion, leading to values of N lower than 4. In no case, however, should values greater than 4 occur, as this would imply more iron corrosion (and, therefore, hydrogen production) than that corresponding to the amount of sulphate reduced.

For our experiments, we used specimens of Armco ingot iron, 6·5 cm. × 1·25 cm. × 0·05 cm. These were exposed to the activity of the bacteria in test-tubes containing exactly 12 c.c. of suitable media, the test-tubes themselves being contained in closed vessels in which anaerobic conditions could be maintained. The basic medium used for experiments under autotrophic conditions was of the following composition: 1 gm. dipotassium hydrogen phosphate, 1 gm. each of ammonium and sodium sulphates, 0·1 gm. calcium chloride ($CaCl_2.6H_2O$), 2 gm. magnesium sulphate ($MgSO_4.7H_2O$) and 1 litre of water. For experiments under heterotrophic conditions, sodium lactate was added to this medium, concentrations of 2·3 gm./l. and 8·1 gm./l. being used. The *p*H of the media was about 7·1 after sterilization. The atmosphere in the anaerobic vessels consisted of nitrogen and carbon dioxide, the latter being at a partial pressure of about 0·3 atmosphere, which was maintained by a solution containing sodium carbonate, sodium bicarbonate and pyrogallol. This solution was contained in the base of the anaerobic vessels and had a *p*H of about 8·6. It also ensured oxygen-free conditions. The experiments were carried out for periods of 8–56 days. The iron specimens, after abrasion and degreasing, were weighed before the experiment and again at its conclusion, after removal of corrosion products by washing and cathodic treatment in ammonium citrate solution. Residual sulphate in the culture liquids was determined gravimetrically as barium sulphate, and the consumption of sulphate was calculated by subtraction from the original sulphate content of the medium. We were thus able to calculate values of the ratio N.

We found, under heterotrophic conditions, values of N ranging from 0·9 to 1·5. In view of the relatively large amount of easily oxidizable lactate present, this result can be regarded as in accord with expectation. In autotrophic medium, however, we obtained values from 5 to 9. By decreasing the sulphate concentration in the medium to 18 mgm./l., we were even able to obtain values of N as high as 48.

We feel that the demonstration, under autotrophic conditions and with pure cultures, of ratios greater

than the theoretical limiting value predicted by von Wolzogen Kuhr's theory is of considerable interest. It indicates that, under the conditions of the experiments, only part of the hydrogen liberated in the corrosion of iron is utilized for sulphate reduction. The remainder of the hydrogen may be accounted for by: (1) evolution as hydrogen gas; (2) reduction of carbon dioxide in building up cellular material; (3) reduction of carbon dioxide to synthesize organic compounds not suitable as hydrogen donors for the bacteria. With regard to (2), the quantity of cellular material formed seemed insufficient to provide an explanation. Of the other possibilities, our present views tend to favour (1). This contention is supported by the results of mass-spectrometer analyses of samples of gas taken from the anaerobic vessels at the end of corrosion experiments. These analyses showed the presence of significant amounts of hydrogen, in the case both of autotrophic-medium and of heterotrophic-medium experiments. We have also carried out corrosion experiments in sterile autotrophic medium, under anaerobic conditions: in this case, any corrosion must necessarily be accompanied by the evolution of hydrogen. We found that the corrosion-rate in such experiments was not significantly different from that in inoculated autotrophic experiments.

It would seem, therefore, that in autotrophic medium the ratio N is merely a measure of the extent to which the bacteria utilize the hydrogen liberated by iron corrosion, and that no acceleration of corrosion is produced by such hydrogen utilization. Further support for this view arises from potential measurements, to be reported separately, in which we have studied the influence of inoculation with sulphate reducers on the corrosion potential taken up by an iron electrode in air-free autotrophic medium. These measurements revealed no significant cathodic depolarization. We therefore consider that the acceleration of corrosion caused by sulphate reducers in heterotrophic medium is not due to the removal of hydrogen, but to some other action of the bacteria. It seems likely that it is in virtue of their sulphide-producing action that the bacteria stimulate corrosion. This point will be dealt with further in the publication on potential measurements.

Permission to publish this note has been granted by the South African Council for Scientific and Industrial Research.

C. J. P. Spruit
J. N. Wanklyn

National Chemical Research Laboratory,
South African Council for Scientific
and Industrial Research, Pretoria.
Sept. 24.

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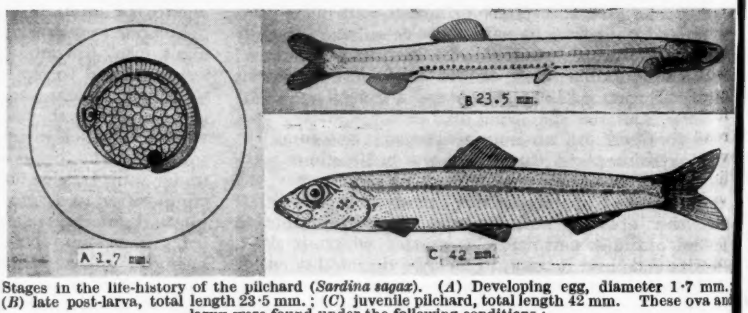
Breeding of Pilchards off the West Coast of South Africa

It was recently stated by T. J. Hart and N. B. Marshall in *Nature* of August 18 (p. 272) that the breeding ground of the pilchard, *Sardina sagax* (Jenyns), had been found off the coast of South-West Africa by the R.R.S. *William Scoresby*. Large numbers of eggs and larvæ were found in March and smaller concentrations in September of 1950.

During the course of investigations started in April 1950, and carried out by the Union of South Africa Fisheries Research Division's R.S. *Africana II*, the pilchard was found to have spawned off the west coast of South Africa over a large area. This area lies between 32° S. and 34° 25′ S., that is, between Lamberts Bay and Cape Point, a distance of approximately 140 nautical miles, and extends from 3 to 90 nautical miles from the coast in depths between 0 and 100 metres. Spawning took place over the period August 1950–February 1951.

A developmental series from the recently fertilized ovum through to the juvenile fish has been obtained. Three of these stages are shown in the accompanying illustrations.



Stages in the life-history of the pilchard (*Sardina sagax*). (*A*) Developing egg, diameter 1·7 mm.; (*B*) late post-larva, total length 23·5 mm.; (*C*) juvenile pilchard, total length 42 mm. These ova and larvæ were found under the following conditions:

	0 Metres	0–50 Metres
Temperature range	14·1–18·4° C.	11·4–18·0° C.
Salinity range	35·0–35·6‰	34·9–35·5‰
Phosphate range	0·23–0·78 P mgm.-atoms/m.³	0·39–1·45 P mgm.-atoms/m.³

Hitherto, it has been impossible to carry out artificial fertilization of the pilchard. This is due to the fact that female pilchards in a ripe and running condition have not so far been caught in South African waters. Data on counts of ova and larvæ, condition of gonads in mature fish from commercial catches and analyses of changes in condition factors show that the spawning season of the pilchard caught in South African waters is mainly in spring and summer, that is, from August to February, with greatest activity in January. It may be mentioned, however, that in no instance have large numbers of either ova or larvæ been obtained, and it is therefore thought that spawning in this area may well be incidental to the presence of great numbers of fish, and that the main focus of spawning of this species lies elsewhere. Unfortunately, no data on the South-West African pilchard are available for comparison with those of the fish caught in Union waters, and it is therefore not certain whether there are two distinct populations or a single population of varying density. The findings of the *William Scoresby* may therefore

be an indication of the main spawning area of the species or another example of incidental spawning. It has shown without doubt, however, that there is a very extended area in which the pilchard may spawn.

The main planktonic organisms found in association with pilchard eggs and larvæ have been found to vary considerably. At times *Sagitta* has been the dominant organism; but eggs and larvæ have also been found in association with *Ctenophores* (*Pleurobrachia*), *Doliolum* and Copepoda. *Cladocera* have been present but only on a few occasions.

It may be mentioned that large numbers of ova, larvæ and juvenile stages of the Cape anchovy *Engraulis japonicus* (Houttyn) have been found in the St. Helena Bay area 1–100 nautical miles offshore. This may prove to be the main spawning ground of this species.

C. Von Bonde
D. H. Davies

Union of South Africa Fisheries Division,
Sea Point, Cape Town. Sept. 26.

Antennæ and Mating Behaviour in *Drosophila melanogaster*

The gene 'antennaless' of *Drosophila melanogaster* does not necessarily express itself fully in individuals homozygous for it[1]. In the course of a programme of work designed to isolate, by means of inbreeding and/or selection, a series of families all homozygous for this gene, but differing in degree of exhibition by reason of the various gene milieux present in the various families, it was noticed that high exhibition lines were conspicuously difficult to maintain. In view of the known chemoreceptive function of the antennæ in insects in general[2] and in *Drosophila* in particular[3], and the importance of the antennæ in the mating behaviour patterns of various species, experiments were started to see whether the poor results obtained with high exhibition lines could be ascribed to failure of adequate mating responses consequent upon absence of stimuli normally reaching the animal *via* these organs. Evidence that males were attracted to females by olfactory stimuli had not been obtained in previous experiments[3].

Three main types of individuals occur in cultures of antennaless stock: those with two antennæ (A_2), one antenna (A_1) and no antennæ (A_0). It is thus possible to set up nine different sorts of mating with respect to two parents. One hundred such 1 × 1 matings were tried for each mating type, and the percentage of successful (that is, fertile) matings was recorded. Results are shown in Table 1.

Table 1

Mating	Total crosses	Successful matings (per cent)
A_0 ♂ × A_0 ♀	100	6
A_1 ♂ × A_0 ♀	100	31
A_2 ♂ × A_0 ♀	100	46
A_0 ♂ × A_1 ♀	100	44
A_1 ♂ × A_1 ♀	100	63
A_2 ♂ × A_1 ♀	100	69
A_0 ♂ × A_2 ♀	100	32
A_1 ♂ × A_2 ♀	100	72
A_2 ♂ × A_2 ♀	100	75

Statistical analysis indicates that it matters little whether an animal has one or two antennæ. What is important is that it should possess at least one antenna. This point is perhaps best made by arranging the crosses in terms of whether neither, one or both parents are antennaless. Such an arrangement is shown in Table 2, where A^- represents a male or female without antennæ, A^+ a male or female with one or two antennæ.

Table 2

Mating	Successful matings (per cent)
$A^- \times A^-$	6
$A^- \times A^+$	31–46
$A^+ \times A^+$	63–75

If we leave aside at present the rather unlikely possibility that the suppression of antennæ in an individual fly is always associated with a corresponding structural or physiological abnormality of the sexual apparatus, we must conclude that the antennæ in *Drosophila* play an important, but as yet undetermined, part in mating behaviour. Their precise function is being investigated at present, and results will be fully published elsewhere.

Michael Begg
Elsie M. Packman

Natural History Department,
University of Aberdeen. July 6.

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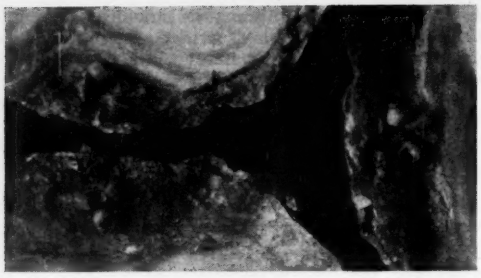
An *Odostomia* attacking Oysters

A detailed account has recently been given[1] of the structure and mode of life of several members of the Pyramidellidæ. It has been shown that they are parasitic and feed by sucking the juices of lamellibranchs and tube worms. The normal hosts are known for only a small number of species, principally of the genus *Odostomia*.

The first species recognized as a parasite was *Odostomia eulimoides*, stated by Jeffreys[2] to occur "chiefly (if not only) on the ears of *Pecten opercularis* and *P. maximus*, in the coralline zone; it is widely distributed and rather common". This description of its mode of life was repeated by Fretter and Graham in their review of the family. It was of interest, therefore, to find the same species attacking oysters in the River Roach, Essex. A sample of a hundred two-year-old native brood oysters dredged from near Paglesham in early June 1951 contained no less than 46 which showed evidence of attack, and many of them actually contained living *Odostomia* when opened at Conway.

The parasites were lodged in small pockets just inside the ventral margin of the shell (see photograph). These pockets result from the withdrawal of the mantle in response to the irritation caused by the proboscis of the parasite during feeding. Apparently the parasites are sedentary, and as a result of continual attack at one point both the right and left mantles are more or less permanently withdrawn for a short distance from the free edge of the shell. In consequence, new shell is laid down in an arc some distance inside the ventral margin and a permanent pocket develops. The parasites occurred mainly in pairs; but in one pocket three were found. Several pockets contained no parasites; but as the oysters had been dredged in Essex, washed, packed and dispatched by post to Conway, some loss during these processes must be expected.

Normally, only one pair of parasites occurred in a single oyster, but one was found with two pockets



Ventral margins of three shells of *Ostrea edulis* attacked by *Odostomia eulimoides*. The parasites are shown *in situ* with hatching spawn alongside. × 2

each containing a pair of *Odostomia*. In many pockets spawn had been deposited and was about to hatch; it appears as a fine granular deposit alongside the parasites.

Although *Odostomia* cannot be regarded as a major parasite of oysters, its attack on the scale recorded must result in considerable irritation, some loss of condition and possibly small permanent malformations. That the irritation is intense is shown by the deposit of patches of conchiolin at the points of attack; such deposits are also laid down in oysters heavily attacked by *Polydora*[3].

It is interesting to note that, in the River Roach, species of *Pecten* or *Chlamys*, the usual hosts of *Odostomia eulimoides*, are absent; apparently it can attack a wide range of lamellibranch molluscs.

I am indebted to Dr. Vera Fretter for the determination of the species of the parasite and to Mr. H. P. Sherwood for the photograph.

H. A. Cole

Fisheries Experiment Station,
Conway,
North Wales.

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Colour Vision of an Albino

According to Gates[1] the frequency of pure albinos is about 1 in 15–25,000 of the population in Scotland. Owing to the kindness of Miss E. C. MacQuade, an albino woman aged about 45–50 years was brought for colour vision tests. She was a pure albino, according to Gates's classification, having cream-white hair, eyebrows and eyelashes, and only a very slight trace of pigment in the iris. She had a continuous nystagmus owing to photophobia, and a divergent squint, for the same reason, using mainly the left eye while the unused eye wandered. She was very short-sighted. Her mother had fifteen children, seven boys and eight girls. She and a younger sister, now deceased, were the only albinos known among all her relations.

Her colour vision was tested with Pickford's four-colour test[2] and the Ishihara test. She was almost red anomalous, without darkening of the red, since the Rayleigh equation for her fell between those of the normal and of the red anomalous shown by Pickford in his Diagram 32 [2]. Her red–green matching range was normal, but she was on the first occasion of testing a yellow deviant. On the second occasion, about three weeks later, her red–green vision was the same, but she was now very blue–yellow weak, with three times the blue–yellow modal matching range. She failed on the Ishihara test, with 15 errors on 24 plates.

Her son and one sister were also tested, and their colour vision was quite normal. Owing to death, age, infirmity or difficulties due to residence and occupation, it was not possible to test any more of her relatives at the time, though further efforts will be made. It is impossible to say definitely whether the red anomaly and the blue–yellow weakness were due to the effects of the albinism or separately inherited.

R. W. Pickford

Psychology Department,
University, Glasgow, W.2.
June 25.

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The *Rh* Chromosome C^wdE (R_1^w) occurring in Three Generations

Fisher and Race[1] postulated the existence of the gene combination *CdE*, and to date four examples have been found (van der Bosch[2], Wiener[3] and Johnson[4]).

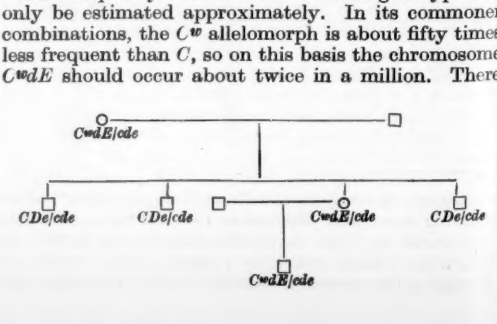
Race *et al.*[5], after reporting the discovery of the Willis antigen, further postulated the existence of the combination C^wdE, but until now this exceedingly rare blood group has not been found. This communication reports the finding of the genotype C^wdE in three generations.

The blood of the propositus—Mrs. "O", an antenatal case—gave no reaction with anti-*D* sera but was agglutinated with anti-*C*, anti-*E* and anti-*c*. Therefore, her genotype was either *Cde/cdE* or *CdE/cde*, which are serologically indistinguishable. Samples of blood from her relatives were investigated with all available sera, including anti-C^w, and a study of the results showed her to be of the genotype C^wdE/cde.

The possibility of the propositus or her relatives having a D^u antigen (Stratton[6]) was excluded by testing their cells with a series of twenty incomplete anti-*D*'s followed by anti-human globulin serum to detect sensitization.

In forecasting the genotype *CdE/cde*, Fisher[1] estimated its frequency should be about 37 in a million, or that one in eight of bloods behaving as *Cde/cdE* would, in fact, be *CdE/cde*. It is interesting to note that we have examined bloods from the families of seven persons behaving as *Cde/cdE* or *CdE/cde*, and Mrs. "O" is the first of the type *CdE/cde* to be found among them.

The frequency of Mrs. "O's" Rhesus genotype can only be estimated approximately. In its commoner combinations, the C^w allelomorph is about fifty times less frequent than *C*, so on this basis the chromosome C^wdE should occur about twice in a million. There



are, however, no strong grounds for expecting the same proportion in the rarer groups; and until we know more, perhaps as many as one in five of the rare chromosomes *CdE* should be regarded as *C^{w}dE*.

Mrs. "O's" blood groups are: *O, H+ve, C^{w}dE/cde, MsNS, P, Le(a−b+), Lu(a−), kk, Jk(a+)*.

We should like to express our thanks to Lieut.-Col. R. H. Malone, director of these laboratories, for permission to publish this communication, to Dr. R. R. Race for his criticism, to Prof. R. A. Fisher for his advice on frequencies, and to Miss E. W. Ikin, Blood Group Reference Laboratory, Lister Institute, London, for confirmation of our findings.

Note added in proof. Since submitting this communication for publication, the *Rh* chromosome *CdE* (*R$_y$*) has been proved to exist in two other families; see Grove-Rasmussen, M., *et al.*, *Ann. Eug.*, **16**, Pt. 2, 131 (1951); and Sussman, L. N., and Wald, N., *Amer. J. Hum. Genet.*, **2**, 85 (1950).

I. Dunsford
P. Aspinall

National Blood Transfusion Service,
Sheffield.

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Relative Importance of Free α- and ε-Amino Groups for the Biological Activity of the Growth Hormone

The biological activity of growth hormone[1] is found to be greatly reduced following treatment with acetic anhydride, which is known to acetylate protein amino groups specifically[2]. The relative importance of free α- and ε-amino groups has not hitherto been investigated. Purified growth hormone has now been acetylated according to the conditions of Li and Evans[1], but with smaller amounts of acetic anhydride so as to avoid complete inactivation.

The fluorodinitrobenzene technique of Sanger[3] was applied to untreated growth hormone in the first instance. The α-dinitrophenyl amino-acids liberated by acid hydrolysis were extracted with ether, and, after passage through a silica gel column, were identified by paper chromatography as dinitrophenyl-alanine and phenylalanine, in accordance with the results obtained by Li and Porter[4] in a preliminary study of the terminal amino groups of growth hormone. Spectrophotometric determination of the α-dinitrophenyl amino-acids was carried out on the eluate from the column. The ε-dinitrophenyl lysine hydrochloride remaining in the ether-extracted hydrolysate was estimated spectrophotometrically after passage through an acidic silica gel column.

Data for Acetylated Growth-Hormone Preparations

Acetic anhydride: moles per mole of growth hormone	Residual free amino groups per mole of growth hormone*		Growth-promoting potency, % of original potency
	Alanine + phenylalanine	Lysine (ε)	
—	1·4	19	(100)
120	<0·1	15·5	53
300	<0·1	13·5	26
2,700	<0·1	9·5	11

* Not corrected for losses in hydrolysis, etc.

When acetylation was performed with a relatively small amount of acetic anhydride, no α-dinitrophenyl amino-acids could be detected following fluorodinitrobenzene treatment of the acetylated product (see table). There was, however, only a partial reduction in the ε-dinitrophenyl lysine content of the hydrolysate and only partial loss of growth-promoting activity (assayed in intact female rats[5]). With larger quantities of acetic anhydride, there was a marked lowering of growth-promoting activity concomitant with increased acetylation of ε-amino groups, as shown by the ε-dinitrophenyl lysine determinations (see table). It thus appears that the growth-promoting activity of the growth hormone depends on the integrity of the ε-amino groups, but not on that of the terminal α-amino groups. The acetylated products were assayed for diabetogenic activity in the intact cat, as will be reported elsewhere. The results indicated that the diabetogenic activity of growth hormone also depends on the presence of ε-amino groups, but not on that of the α-amino groups.

The finding that acetic anhydride can be employed to acetylate selectively the free α-amino groups of growth hormone may be applicable to other proteins possessing both free α-amino groups and free ε-amino groups.

I am indebted to the Beit Memorial Trust for the award of a fellowship, to Dr. F. Sanger for advice on the use of his technique, and to Prof. F. G. Young for helpful advice and criticism.

E. Reid

School of Biochemistry,
University of Cambridge.
July 19.

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Bacterial Enzyme Preparations oxidizing Inositol and their Inhibition by Colchicine

Previous studies in this laboratory have brought to light a number of regularities governing the oxidation of isomers of the inositol group by resting *Acetobacter suboxydans*[1,2]. If the hexahydroxy *cyclo*-hexanes are formulated as existing in the chair configuration, the minimum steric requirements for the oxidation of the various isomers by the resting cells are described in the statement that only those hydroxyl groups are oxidized that are situated in a polar plane.

The study of many aspects of these oxidative reactions required enzyme preparations in the cell-free state[3]. A thick suspension in 1/15 *M* phosphate buffer (*p*H 6·4) of the organisms, grown and harvested as described previously[2], was passed through a bacterial mill (Unicam, Cambridge). About one-half of the cells was broken. After centrifugation of the mixture (30 min., 2,000 *g*) and re-extraction of the sediment with buffer on a vibrator (60 vibrations per sec.) for 12 hr., followed by an intermediate centrifugation cycle at 11,000 *g* (1 hr.), the combined supernatants were finally centrifuged at 20,000 *g* for 2 hr. The reddish-brown pellet was suspended in phosphate buffer of *p*H 6·4. All operations were carried out in the cold.

The oxidation of glucose to gluconic acid and of sorbitol to sorbose are among the well-known activities of resting *Acetobacter suboxydans*. The first function was retained in the cell-free enzyme preparations. Glucose was attacked with the consumption of 1 gm.-atom of oxygen per mole of substrate. During the oxidation the *p*H changed from 6·4 to 5·8; neither carbon dioxide nor lactic acid was formed. Sorbitol, however, was not oxidized.

The abilities of the organisms to oxidize *meso*-, *d*- and *epi*-inositol, *d*-quercitol and *dl-epi*-inosose all were preserved in the cell-free enzyme preparation, but not without the presence of an additional factor, which was, however, not required for the oxidation of glucose. Suspensions of the pellet alone oxidized *meso*-inositol only very slowly. The addition of washed, heat-inactivated *Acetobacter* cells accelerated the reaction very markedly. 1 gm.-atom of oxygen was consumed by 1 mole of *meso*-inositol. Although the monocarbonyl or dicarbonyl derivatives, previously shown to be formed from the various stereoisomers by the resting organisms[2,4,5], were not isolated, the manometric experiments left little doubt that the same reaction products were formed by the isolated enzyme system. The latter, as was previously also found with resting cells[3], failed to attack pinitol, a methyl ether of *d*-inositol.

The enzyme preparations were completely inactivated by heating (20 min., 80°). The *p*H optimum at 36° (in phosphate or veronal buffer) was at 6·4. The Michaelis constant was 0·0036 *M* (compare curve *A* in Fig. 1). Saturation of the enzyme system was achieved when 3–4 mgm. (dry weight) of the enzyme preparation and 20–30 mgm. of heat-inactivated cells were contained in 3 c.c. of a 0·0365 *M* solution of *meso*-inositol in buffer. Potassium cyanide, in a 0·001 *M* concentration, totally inhibited the enzyme system.

What appears to be a more specific inhibition was discovered when it was found that colchicine and some related compounds containing a seven-membered ring prevented the oxidation of the inositols, but not of glucose, by the isolated enzyme preparations. (No effect on intact resting organisms was observed, owing, probably, to the slowness of permeation.) Several representative experiments are assembled in Figs. 1 and 2. This inhibition seems to be non-competitive. Both the slopes and the intercepts increased with increasing concentrations of colchicine, when the reciprocals of the velocity constants were plotted against the reciprocals of substrate concentration (Fig. 1). Experiments with varying concentrations of the components of the complete enzyme system showed that the effect of colchicine was exerted on the cell-free enzyme itself and not on the additional heat-stable factor. A five-fold increase in the concentration of the latter doubled the rate of oxygen uptake, but scarcely changed the extent of inhibition.

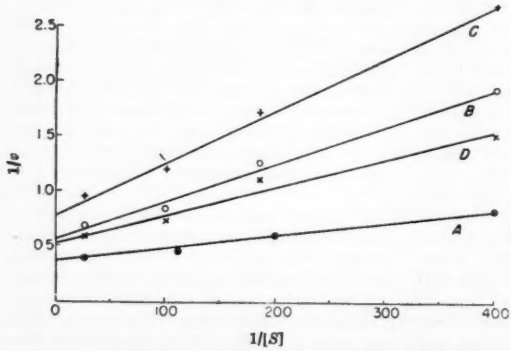

Fig. 1. Oxidation of *meso*-inositol by *Acetobacter* enzyme as a function of substrate concentration, and its inhibition by colchicine and tropolone.

v, rate of oxygen uptake (cu.mm./min.); [*S*], substrate concentration (moles/litre). Each vessel contained 4·37 mgm. of enzyme, 30 mgm. of heat-inactivated cells (dry weights) and varying amounts of substrate in a total volume of 3 c.c. of 1/15 *M* phosphate buffer (*p*H 6·4, 36°). Curve *A*, no inhibitor; curve *B*, 0·0033 *M* colchicine; curve *C*, 0·0066 *M* colchicine; curve *D*, 0·0056 *M* tropolone. In the inhibition experiments, the enzyme was left in contact with the inhibitor for 20 min. at 36°, before the substrate was added

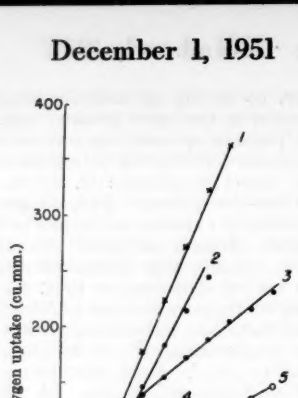

Fig. 2. Effect of colchicine on the oxidation of glucose (curve 1), *meso*-inositol (curves 2 and 3), and *d*-inositol (curves 4 and 5) by *Acetobacter* enzyme.

Each vessel contained 3·8 mgm. of enzyme and 25 mgm. of heat-inactivated cells (dry weights) in 3 c.c. of buffer. The concentration of colchicine, added 28 min. after the beginning of the experiments (indicated by arrow), was 0·0067 *M*. Substrate concentrations: glucose, 0·019 *M* (curve 1, with and without inhibitor); *meso*-inositol, 0·0089 *M* (curve 2 without, curve 3 with inhibitor); *d*-inositol, 0·0081 *M* (curve 4 without, curve 5 with inhibitor)

Preliminary results indicate that simpler *cyclo*-heptane derivatives[6], namely, tropolone[7–9] and 4,5-tetramethylene tropolone, have a similar inhibiting effect on the oxidation of inositols (compare curve *D* in Fig. 1). At the level of enzyme-saturation, tropolone inhibited the system almost completely at a 0·011 *M* concentration and to the extent of 60 per cent at a 0·0056 *M* concentration; 0·0067 *M* colchicine showed a 70 per cent inhibition. The oxidation of smaller quantities of substrate (0·018 *M* *meso*-inositol solution) was completely blocked by 0·006 *M* colchicine.

It would be premature to construct analogies between the effects described here and the well-known action of colchicine as a mitotic poison. It may, however, not be entirely irrelevant that recent work in this laboratory has shown *meso*-inositol to have a specific effect in preventing colchicine from producing metaphase arrest[10,11].

We are greatly indebted to Drs. Doering and Knox for supplying the tropolone specimens and to Hoffmann–LaRoche, Basle and Nutley, for a supply of colchicine. This work, which will be presented in detail at a later date, has been supported by grants

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ROBERT E. FRANZL
ERWIN CHARGAFF

Department of Biochemistry,
College of Physicians and Surgeons,
Columbia University,
New York 32, N.Y.
July 19.

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Dephosphorylation of Adenosine Triphosphate in Muscular Contraction

CONTEMPORARY views on the role of adenosine triphosphate in contractile activity include the assumption that the breakdown of this substance is the immediate chemical source for mechanical energy[1,2]. However, as has recently been emphasized by A. V. Hill[3], there is no proof that such a dephosphorylation occurs as an early event in contraction. Furthermore, it has been shown[4] that the effects of adenosine triphosphate upon certain physical properties of actomyosin do not primarily involve splitting of the nucleotide. The experiments reported here were undertaken in order to decide whether, indeed, any dephosphorylation of adenosine triphosphate occurs during the contractile phase of a twitch.

It appears unfavourable to attempt the detection of a diminution of adenosine triphosphate by analysis of the hydrolysable phosphate (compare Lundsgaard[5]), since one would have to evaluate small differences between large numbers, which might furthermore be distorted by the formation of other labile phosphate compounds. Instead, we have employed a chromatographic assay method, closely resembling that of Cohn[6], to determine adenosine mono-, di- and triphosphate separately by their ultra-violet absorption.

The experiments were carried out with the combined leg muscles of frogs. Muscles from the two legs were isolated, care being taken to subject the two sets to the same manipulations. Starting at a temperature of about 20° C., one set was immediately extracted with ice-cold 1 *N* perchloric acid, whereas the other set was fixed at the height of contraction by sudden submersion into liquid air (compare Lundsgaard[5]). The results are shown in the accompanying table.

It is seen that in contraction there is a pronounced decrease of adenosine triphosphate, and that its breakdown goes in part beyond the stage of the diphosphate, probably by the myokinase mechanism. The decrease of adenosine triphosphate averages about one-fifth of the total nucleotide, which is about twice the expected amount[7]. If confirmed, this would indicate that precipitous cooling mobilizes the contractile apparatus to a somewhat greater extent than occurs physiologically in a single twitch, or else that in this mode of stimulation part of the muscle twitches more than once. We intend to study various other ways of eliciting contraction in different types of muscles.

DISTRIBUTION OF ADENINE NUCLEOTIDES AS A PERCENTAGE OF THE TOTAL NUCLEOTIDE FRACTION, FOR FROG MUSCLE AND (LAST LINE) FOR RABBIT PSOAS MUSCLE

Control			Contracted			Difference		
AMP	ADP	ATP	AMP	ADP	ATP	AMP	ADP	ATP
7·5	14·5	78·0	9·0	26·8	64·2	+1·5	+12·3	−13·8
6·3	13·5	80·2	10·0	15·9	74·1	+3·7	+2·4	−6·1
8·6	14·0	77·4	5·5	37·4	57·1	−3·1	+23·4	−20·3
8·6	44·7	46·7	14·8	55·8	29·4	+6·2	+11·1	−17·3
5·3	22·3	72·4	6·0	44·9	49·1	+0·7	+22·6	−23·3
12·8	12·2	75·0	16·8	39·8	43·4	+4·0	+27·6	−31·6
2·2	12·7	85·1	5·2	16·2	78·6	+3·0	+3·5	− 6·5

In sustained muscular activity, and possibly also in a completely reversed twitch, a breakdown of phosphocreatine rather than of adenosine triphosphate is generally detected (see ref. 2). Our present results suggest, however, that it is primarily adenosine triphosphate which is dephosphorylated in the contractile phase. Apparently, a transfer of phosphate from phosphocreatine to adenosine di- and monophosphate by the Lohmann reaction[8] occurs only in later phases of the contractile cycle. We suggest that actually the Lohmann reaction is specifically connected with relaxation.

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W. F. H. M. MOMMAERTS
JOSEPH C. RUPP

Department of Biochemistry,
Duke University School of Medicine,
Durham, North Carolina.
July 27.

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Transaminases in *Neurospora crassa*

THE presence of a wide range of transaminases in both animal tissues[1] and bacteria[2] has recently been reported. A rather similar array of enzymes appears to be present in the mould *Neurospora crassa*.

Mycelium of the wild-type strain *E5297a* was grown for three days at 25° in 'minimal' Fries No. 3 medium, and cell-free extracts were obtained by grinding with phosphate buffer and powdered glass followed by centrifugation as described in detail elsewhere[3]. The extracts, which were free of large

particles but turbid owing to the presence of small particles just visible under the high power of the microscope, were dialysed against cold *M*/15 phosphate at *p*H 7·4. Dialysed extracts contained about 1 mgm. of nitrogen per ml.

The formation of glutamate following the incubation of extracts with α-ketoglutarate and different amino-acids was shown by paper chromatography of the deproteinized digests[4], phenol saturated with water being used as the running solvent. It was possible to obtain a roughly quantitative estimate of the glutamate formed by visual comparison of the experimental glutamate spots with a graded series of glutamate standards chromatographed under identical conditions. Glutamate concentrations were recorded as either intermediate between two standards or as approximately equal to one of the standards when they could not be seen to differ from it in intensity.

Table 1. Test-tubes Each Containing: 0·45 ml. *M*/15 L-Amino-Acid; 0·15 ml. *M*/5 Sodium α-Ketoglutarate at *p*H 7; 0·40 ml. Mycelial Extract Dialysed against *M*/15 Phosphate at *p*H 7·4. Incubation at 34° for 3 hr.

Amino-acid	Conc. of glutamate (millimoles/l.)	Amino-acid	Conc. of glutamate
Water control		L-Tryptophan	2–3
(*a*) Zero time	0	DL-Methionine	3
(*b*) Incubated	1–2	DL-α-Aminobutyric acid	4–6
Glycine	2	DL-*nor*Valine	6
L-Lysine	1–2	DL-Valine	10
L-Serine	1–2	DL-*nor*Leucine	10
DL-Threonine	1–2	L-*iso*Leucine	10–13
L-Proline	1–2	L-Leucine	10–13
L-Cysteine	1–2	L-Aspartate	13*
L-Histidine	2	L-Alanine	16†

* Some alanine also formed. † Approximating to 50 per cent transamination.

All amino-acids tested showed some degree of transamination except glycine, serine, threonine, lysine, histidine and cysteine, which, if they reacted at all, gave less than 3 per cent transamination during three hours. The apparent small formation of glutamate in the cases of methionine and tryptophan was confirmed in repeated experiments. It has been found repeatedly that incubation of *Neurospora* extracts with α-ketoglutarate and ammonium chloride yields no glutamate under the conditions of these experiments.

To determine whether the transaminases were attached to particles (as found by Hird and Rowsell) or present in solution, a turbid extract obtained by the usual procedure was filtered by suction through a 4-mm. pad of kieselguhr to give an opalescent solution free of particles. As shown in Table 2, the greater part of all the transaminases tested were found to be present in the filtrate; part, at least, of the loss of activity on filtration can be attributed to dilution by moisture present in the filter pad. This experiment, and many others involving relatively short incubation times, shows that transamination at *p*H 7·4 is most rapid with alanine as the amino donor.

In addition to the amino-acids listed in the tables, ornithine has been shown to be acted upon by a *Neurospora* transaminase, its effectiveness as an amino donor being about equal to that of *nor*valine in the type of experiment outlined above.

It was found that amino-group transfer to α-ketoglutarate from *iso*leucine, ornithine or phenylalanine was more rapid at *p*H 8 than at either *p*H 7 or *p*H 9, while in the case of aspartate the reaction

Table 2 Test-tubes Each Containing 0·3 ml. *M*/15 L-Amino-Acid, 0·1 ml. *M*/5 Sodium α-Ketoglutarate, and 0·2 ml. Extract Buffered as in Table 1. Incubation at 34° for 1 hr.

Amino-acid	Conc. of glutamate formed (millimoles/l.)	
	Extract filtered	Extract unfiltered
Water control	1	1–2
L-Alanine	12	15
DL-α-Aminobutyric acid	3–4	4
DL-*nor*Valine	4	6
DL-Valine	8–10	10
DL-*nor*Leucine	5–6	6
L-Leucine	6	8–10
L-*iso*Leucine	5–6	8–10
DL-Phenylalanine*	3	5
L-Tryptophan	1–2	1–2†
DL-Methionine	2	3
L-Aspartate	8	10

* Concentration *M*/30 of L-isomer. † More than control.

was rather more rapid at *p*H 9 than at *p*H 8. At *p*H 9 aspartate reacted faster than alanine. The behaviour of alanine was strikingly different, the apparent optimum *p*H in this case being in the region of 5·5–6·0. The formation of glutamate from alanine and α-ketoglutarate was, at initial *p*H 5·5–6·0, accompanied by a rise in *p*H of about one unit, and it seems likely that the rate of decarboxylation of pyruvate was a factor contributing to the rate of transamination.

It is interesting to note that the activities of the different amino-acids in transamination *in vitro* show a rather close correlation with their effectiveness in supporting growth of 'amination-deficient' mutant strains[5] which apparently lack glutamic dehydrogenase[3] and require exogenous α-amino-nitrogen for growth. Methionine, which is a relatively very effective amino donor for the intact mould, while being acted on only slowly by extracted transaminase, is the only striking exception.

J. R. S. Fincham

Department of Botany,
University College,
Leicester.
July 5.

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Proteolytic Activity in Hen's Egg prior to Incubation

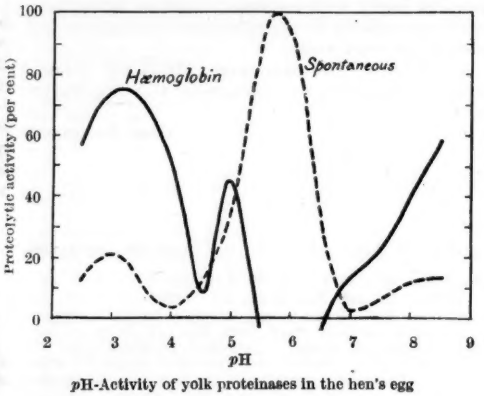
For this investigation, I used highly fertile eggs of pure breed (White Leghorn), laid in the afternoon. The eggs were stored at low temperature for a maximum of three days.

For chromatographic assay of free amino-acids, white and yolk were homogenized separately and extracted with alcohol in final concentration of 80 per cent. Two-dimensional chromatograms were run in (1) butanol – acetic acid – water and (2) phenol – water. The chromatograms were dried in an air current at approximately 50° C. and developed with ninhydrin. Munktell *OB* paper was used. For hydrolysis tests extracts were treated with 6 *N* hydrochloric acid for six hours. Chromatograms sprayed with basic copper carbonate gave no spots with ninhydrin. The results of chromatography are evident from the accompanying table.

Substance	*Rf* value in butanol–acetic acid–water	*Rf* value in phenol–water	Intensity of spots	Approx. conc. in yolk (mgm. per cent)
Peptide containing lysine	0·09	0·21	+	
Lysine*	0·07	0·35	+++	150
Aspartic acid	0·21	0·40	++	
Unknown*	0·23	0·34	+	
Arginine	0·13	0·45	+++	150
Glycine	0·22	0·45	+	
Glutamic acid	0·30	0·45	++	
Threonine	0·28	0·54	++	
Citrulline	0·20	0·64	+	
Alanine	0·34	0·58	+++	60
Unknown	0·22	0·81	+	
Tyrosine	0·46	0·64	+	
Valine	0·52	0·79	++	
Leucine	0·68	0·85	+++	100

* Obtained after hydrolysis.

The various amino-acids are all among those reported from yolk-protein[1]. In the white, there are no demonstrable free amino-acids; but in the yolk freed from the blastoderm the concentration is exceptionally high. Consequently, mobilization of amino-acids occurs in the yolk apparently independently of the embryo. For this reason it may be assumed that pre-formed proteolytic enzymes are active in the yolk.



*p*H-Activity of yolk proteinases in the hen's egg

For determination of this expected proteolytic activity, extracts of yolk freed from blastoderm were made with glycerol–water (30 per cent) and used immediately. As substrate undenatured hæmoglobin was used in 1 per cent solution. Merthiolate was added. Samples mixed with buffer solution (Mac-Ilvaine's standard buffer) were incubated at 39° C. for 2 hr. The proteolysis was stopped by adding trichloracetic acid (5 per cent). Samples were examined in the spectrophotometer at 2750 A. for liberated cyclic amino-acids. Rectilineal curves were obtained for at least five hours. From the accompanying graph it is apparent that there are at least three proteinases in the yolk, acting at different *p*H's. The spontaneous activity around *p*H 6 is very high, and addition of hæmoglobin has apparently an inhibiting effect thereupon.

The work is being continued and further results will be published elsewhere.

HADAR EMANUELSSON
Zoophysiological Institution,
University, Lund.
June 15.

[1] Romanoff, A. L., and Romanoff, A. J., "The Avian Egg", 334 (1949).

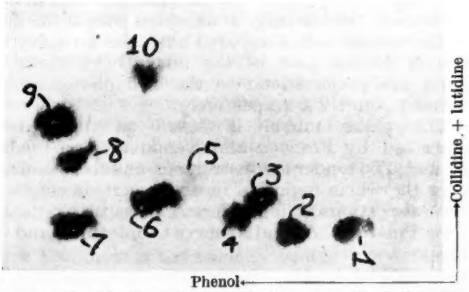
Chromatographic Analysis of Amino-acids of Molasses and other Beet-sugar Industry By-products

WE have applied chromatographic analysis to the detection of the amino-acids present in beet molasses and other by-products of the sugar-beet industry.

We used the descending paper-chromatography technique described by Consden, Gordon and Martin[1]; Whatman No. 1 paper, and the phenol, lutidine + collidine system were used. A 0·1 per cent solution of ninhydrin in butanol was used for detecting the spots.

Most of the chromatograms were obtained without any purification of exhausted molasses; in every run we used 5 mgm. of substance dissolved in distilled water (1 : 10 w/v). The chromatograms show nine spots well separated; after several trials we are able to attribute the spots to the following amino-acids: aspartic, glutamic, γ-aminobutyric, serine, glycine, alanine, valine, leucine, tyrosine. A good deal of pyrrolidone carboxylic acid is also present. This does not give a spot with ninhydrin; but the chromatograms made after treatment by acid hydrolysis of the molasses show a broader and more intense spot of glutamic acid. No traces of basic or sulphurated amino-acids were found. A detailed account of this work will be published elsewhere.

Applying a desalting procedure to the molasses solutions we obtained clearer chromatograms, with sharper spots. For this purpose we used a desalting apparatus analogous to that described by Consden, Gordon and Martin[2]. The chromatograms obtained in this way give, besides the nine spots already identified, another spot, much weaker than the others, due to threonine. The accompanying photograph is of a chromatogram obtained with desalted molasses.



(1) Aspartic acid, (2) glutamic acid, (3) serine, (4) glycine, (5) threonine, (6) alanine, (7) γ-aminobutyric acid, (8) valine, (9) leucine, (10) tyrosine

Regarding the quantity of amino-acids, in so far as the spots show, we can say that the most intense spot is that due to alanine; the γ-amino-butyric, glutamic and leucine spots follow in order of intensity. The spots due to aspartic acid, glycine, serine, valine and tyrosine are less intense.

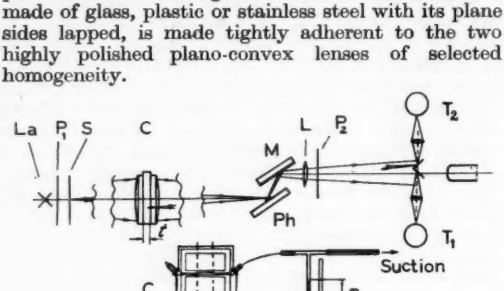
We have found the same amino-acids in a sample of concentrated baryta-process waste liquors, and in different samples of first-run molasses.

EUGENIO MARIANI
GIORGIO TORRACA
Istituto di Chimica Applicata ed Industriale,
Facoltà Ingegneria, Università di Roma.
June 30.

[1] *Biochem. J.*, **38**, 224 (1944).
[2] *Biochem. J.*, **41**, 580 (1947).

A Highly Sensitive Phase-Contrast Refractometer for Liquids and Gases

The accompanying diagram shows the essential parts of a refractometer using the principle of phase contrast, which is new for this class of instrument. It gives relative measurements, like most of the applications of the Jamin and the Rayleigh refractometers depending on interference. The liquid or gas to be measured is enclosed in the central horizontal cell C about 1 mm. in height, the reference liquid or gas filling the upper and lower portions. The plane-parallel frame forming the middle of the cell, and made of glass, plastic or stainless steel with its plane sides lapped, is made tightly adherent to the two highly polished plano-convex lenses of selected homogeneity.



The optical system is symmetrical about this lens-like cell. An image of the entrance slit S, illuminated by monochromatic 5461 A. light from a mercury lamp, is formed by this cell on the central part of the phase mirror Ph. Then the light is passed, by means of the mirror M, through the lens L, which forms, in the plane dotted in the diagram, the phase-contrast image of the cell C. This image can be viewed by an eyepiece or a microscope. But in order to measure the intensity of a defined part of the image of the central cell, compared with the intensity of a second defined part of the image field, these two parts are projected on to the two photomultiplier tubes T_1 and T_2, respectively.

The phase mirror is based on the principle described by Françon and Nomarski[1] and modified by me[2]. To render the instrument uniformly sensitive over the whole region of measurement, it consists of several portions giving different phase-turning angles. Two 'Polaroids' P_1 and P_2 serve to determine and vary the vector origin.

According to the theory previously given[3,4], the difference of refractive index between the two liquids, $n_2 - n_1$, is determined by the intensity ratio between the two fields. This is a function of the path difference or, more exactly, of the phase difference angle $(n_2 - n_1)t.2\pi/\lambda$. It may be an arbitrary part of a complete turn, or several turns, but full details of the procedures cannot be given here, only mentioning that the number of whole turns is counted as the displacement of the zero order fringe from a double slit system as used in Young's experiment.

A very simple experiment is to make the optical path difference exactly one wave-length, that is, the phase angle exactly 2π, since it can be done visually by equalizing the intensities as in a Lummer–Brodhun photometer. The air of the central cell is pumped out, and the positions of the manometer corresponding to equal field intensities are noted. The difference of pressure equivalent to one wave-length was found to be 149 mm. of mercury; the thickness t being 10·4 mm. and the air temperature 22·4° C. This gives a refractive index of $2{\cdot}68 \times 10^{-4}$ for air of the same temperature and 760 mm. mercury pressure. When reduced to 20·0° C., the result is $2{\cdot}70 \times 10^{-4}$, which, considering the very simple means used for making the measurements, is in good accordance with the precision measurements of $2{\cdot}731 \times 10^{-4}$ [5].

In this Laboratory we measure photoelectrically with an accuracy of 0·5 per cent per amplitude in a phase-contrast field. As the vector is about unit length, the accuracy approximates to $0{\cdot}5 \times 10^{-2}/2\pi$ of a turn, or for the refractive index difference at $t = 10$ mm., which thickness contains 18,300 periods, the precision is 5×10^{-8}. This is more than ten times better than the results obtained by any interferometer[5]. An amount of at least 0·1 cm.³ of the liquid under examination is necessary and about 10 cm.³ of reference liquid. For a mixture of heavy and ordinary water, this means an accuracy of analysis of 0·001 mole per cent. Measurements have not yet been made on account of the lack of precise reference standards.

The precision can be reduced by making t smaller, and it can probably be raised by increasing it to some centimetres. This is possible with maintained focusing of the image, as the focal lengths must be rather long for other reasons. The temperature remains fairly well constant because the measuring cell is surrounded by the reference liquid and separated from it by thin walls.

I am now working with Mr. Lars Johansson, chemical engineer, to elaborate the apparatus for routine use.

Erik Ingelstam

Optics Laboratory,
Royal Institute of Technology,
Stockholm 70.
July 3.

[1] Françon, M., and Nomarski, G., *C.R. Acad. Sci., Paris*, **230**, 1392 (1950).
[2] Ingelstam, E., *Ark. Fys.*, **3**, No. 2 (1951).
[3] Ingelstam, E., *Ark. Fys.*, **3**, No. 20 (1951).
[4] Ingelstam, E., Colloque intern. sur le contraste de phase et le contraste par interférence, Paris, May 1951 (in the press).
[5] See, for example, Candler, C., "Modern Interferometers" (London, 1951).

Fly Reactions to Insecticidal Deposits: a New Test Technique

Most laboratory methods for evaluating residual insecticides involve crowding a number of flies together in rather small containers. Such crowding stimulates activity, which may cause the flies to pick up abnormal amounts of insecticide. These conditions are unnatural, and while useful and reproducible results may be obtained, their relevance to field performance is doubtful.

We have found that the difficulties can be overcome by using a 'single fly' technique, based on the exposure in a large treatment cage of one fly at a time. Interference from other flies is avoided and fly behaviour can be studied in detail. Three-day-old well-fed female houseflies, which, if undisturbed, normally remain immobile on an untreated surface for three to five hours at 24–26° C., were used in all tests.

A cubical cage of 2-ft. side forms the container, and is about the minimum size in which a fly shows no reaction to confinement. The cage consists of a light wooden frame having a paper back as the treat-

ment surface, the sides and top covered with mosquito netting, and the bottom open and resting on a table covered with clean paper. The fly is introduced by tilting the cage, allowed to settle, and induced by tapping the sides to come to rest on the treated surface. It is then left undisturbed and watched. When it leaves the surface, and when it is knocked down, the time is recorded; the fly is caught and placed in a separate small individual cage for subsequent observation. Before and after test the flies are fed on milk and kept at 24–26° C. It was found that minor changes in environment affected the results, hence comparative tests were run concurrently in adjacent cages.

The results obtained in a typical series of tests are summarized in the accompanying table, in which averages and standard deviations are given. The tests were made with a normal strain of *M. domestica* with unglazed wallpaper as the treatment surface; there were ten replicates.

Treatment	Resting period (min.). Average and standard deviation	Time to knock-down (min.) from beginning of resting period. Average and standard deviation	Mortality % after 24 hr.
DDT dispersible powder at 250 mgm. *pp'* isomer per sq. ft.	10±2·8	See below*	20
Crude BHC dispersible powder at 25 mgm. γ per sq. ft.	22±4·8	38±7·9	100
γ BHC dispersible powder at 25 mgm. γ per sq. ft.	29±3·2	35±4·3	100

* No knockdown in eight cases; knockdown in 3½ and 24 hr. for remaining two.

The results show that consistent treatment differences can be obtained with very few flies. The most striking observation is that the flies on BHC deposits do not leave the surface until they have acquired a lethal dose, whereas the flies on DDT deposits leave the surface much earlier, and mainly survive. Before leaving the surface, the DDT flies are obviously disturbed, as shown by the frequency of cleaning operations and erratic movements, whereas the BHC flies are comparatively quiescent. This abnormal behaviour of the DDT fly persists for about an hour after the surface is left. Many similar comparisons were made and gave the same results. At 100 mgm. of DDT per sq. ft. no knockdown or kill resulted in twenty-four hours from this single contact.

Preliminary tests with *Aedes ægypti* on similar lines have shown similar results on a much reduced time-scale, and further tests with this and *Anopheles* spp. are in hand.

It is felt that differences in behaviour of this kind must operate, to some degree, in the field and that, therefore, laboratory data obtained by this method can be of help in interpreting and predicting field results. The study of such differences in behaviour may throw light on the development of resistance by insects to certain chemicals.

F. Baranyovits

Hawthorndale Laboratories,
Imperial Chemical Industries, Ltd.,
Jealott's Hill,
Bracknell,
Berks.
July 2.

Gravitation in Kinematic Relativity

A crucial test of a relativity theory of gravitation is its ability to explain (*a*) the perihelion advance of a planetary orbit as observed in the case of Mercury, and (*b*) the deflexion of light in a gravitational field as observed in the field of the sun. Another, completing the trio of tests which Einstein's general theory satisfied with such notable success, is in a different category, since it involves some hypothesis concerning the 'proper' frequencies of atomic vibrations; this is (*c*) the shift of the spectral lines emitted by atoms near a massive body, as observed in the case of light from the sun and from the companion to Sirius. It is not difficult to apply tests *a* and *b* to the gravitational part of Milne's theory[1], assuming that the equations of motion given by Milne hold in the field of the sun. The results are that, first, there is a perihelion motion, but it is in the wrong direction, and secondly, there is no gravitational deflexion of light. The failure under the first test could perhaps be accounted for by the fact that the sun is not at rest in the substratum; but if this were so, the perihelion effect would depend critically upon the sun's velocity relative to the substratum and upon the orientation of the planetary orbit under consideration. On the whole, it appears that Milne's dynamical theory does not compare favourably with Einstein's general theory.

This conclusion should not be regarded as reflecting on the whole of Milne's kinematic theory, for it has already been remarked[2] that Milne's system of dynamics is not an inevitable consequence of his fundamental principles, but is only one of a number of possible systems. A theoretical defect of Milne's system is that it does not satisfy a least action principle. This can be remedied by starting with a variational equation having the required Lorentz invariance; and one of the systems arising in this way, analytically the simplest, is particularly interesting because it leads to precisely the same perihelion motion and deflexion of light as given by general relativity. This system can be described briefly in terms of Newtonian space and time, the curvature of space-time being neglected since we are now concerned only with local effects.

Consider the variational equation

$$\delta \int \exp(-2\varphi/c^2)\,(c^2 + \mathbf{V}^2)\,dt = 0, \qquad (1)$$

where $\mathbf{V} = d\mathbf{r}/dt$ is the velocity vector, c is constant, and $\varphi(\mathbf{r})$ is the Newtonian potential function. This leads to equations of motion which can be written:

$$\frac{d}{dt}\left(\frac{\mathbf{V}}{1-\mathbf{V}^2/c^2}\right) + \frac{1+\mathbf{V}^2/c^2}{1-\mathbf{V}^2/c^2}\,\mathrm{grad}\,\varphi = 0, \qquad (2)$$

and an 'energy integral':

$$\varphi + c^2 \log(1 - \mathbf{V}^2/c^2)^{-1/2} = \text{constant}, \qquad (3)$$

giving the classical $\varphi + \frac{1}{2}\mathbf{V}^2 = \text{constant}$ when $c \to \infty$.

The scalar velocity of a test particle cannot exceed c, and a particle moving initially with speed c continues to move with this speed. Identifying such particles with light photons, it follows that their paths are given by the variational equation

$$\delta \int \exp(-2\varphi/c^2)\,ds = 0, \quad ds^2 = d\mathbf{r}^2. \qquad (4)$$

Thus light paths are the geodesics of a conformally flat 3-space.

Motions in the field of a massive particle M, for example the sun, are found by substituting $\varphi = -\gamma M/|\mathbf{r}|$. It can be calculated from (2) that an orbit has an advancing perihelion, and from (4) that light is deflected towards the sun. In each case the formula is exactly the same as that given by general relativity[3].

An attempt to introduce the third Einstein test could be made by interpreting the variational equation (4) as giving least time in accordance with Fermat's principle; this would suggest that the frequency of an individual photon at any point of its path is proportional to $\exp(-2\varphi/c^2)$. In the case of light from a massive body the resulting spectral shift would be twice as large as that predicted by general relativity.

The simplicity of equation (1), with its success in giving at least two of the observed relativistic effects, suggests that it should be applied to material systems which are too complicated to be handled by the field equations of general relativity. It would be interesting to see if it leads to the prediction of any new observable relativity effects.

A. G. Walker

Department of Mathematics,
University, Sheffield 10.
June 26.

[1] For an account of this theory, see Milne, E. A., "Kinematic Relativity" (Oxford, 1948).
[2] Walker, A. G., review of "Kinematic Relativity", *Math. Gaz.*, **33**, 304 (1949).
[3] See Eddington, A. S., "Mathematical Theory of Relativity", Chapter 3 (Cambridge, 1930).

An Attempt to Measure the Annual Parallax or Proper Motion of Four Radio Stars

Previous attempts to measure the annual parallax of intense radio stars[1,2] have indicated that their distances exceed 1/50 parsec. These results were obtained by using an interferometer arrangement to determine the positions of individual stars over a period of many months. Observations of this type are limited by inconstancy of the phase retardations in the transmission lines connected to the aerials of the interferometer. This source of error, which is analogous to the collimation error of a visual transit telescope, may, however, be largely eliminated if observations are made of the *relative* positions of a number of radio stars. The difference of the right ascensions of two stars of considerable angular separation should vary periodically as the earth goes round its orbit. It can be shown that a determination of the amplitude and phase of this periodic variation leads to a knowledge of the true parallax of each star separately. In addition, if no relative angular motion between a number of stars can be detected, it is unlikely that any of them has a proper motion greater than the accuracy of the observations.

The accuracy with which the difference of the right ascensions of two or more radio stars may be determined is very much greater than the absolute accuracy of the interferometer system, since the collimation error need only remain constant for the duration (a few hours) of the experiment. The most serious remaining error is caused by ionospheric refraction near dawn and dusk, when the ionosphere is not horizontally stratified. This produces a deviation in apparent right ascension and affects observations of parallax but not of proper motion. The magnitude of the error is greater at the longer wavelengths.

Two series of observations have been carried out in an attempt to measure the annual parallax or proper motion of the four intense radio stars 05·01, 12·01, 19·01, 23·01 [3]. The first series was made with the large 3·7 m. interferometer[3], and has lasted for one year. Accurate observations were made of the apparent right ascension of each star on about four days each week. Such frequent observations were necessary owing to the large number of occasions on which irregular ionospheric refraction prevented accurate measurements[4]. The second series consisted of similar observations on a wave-length of 1·4 m. these observations have been maintained twice a week for four weeks in each of the periods shown in the accompanying table.

For each group of observations lasting two or four days a value of the collimation error was found by taking the mean of the deviations of the recorded positions from a fixed position for each of the four stars. The difference between the recorded deviation and this mean value was then taken as the apparent movement of the star. Allowance was made for the effects of aberration, nutation and precession.

The observations on 3·7 m. wave-length clearly showed the dawn and dusk refraction mentioned above; the angular movements due to this were approximately ½ minute of arc. An analysis of these results is being made which may give information on the magnitude of the horizontal gradient of electron density in the ionosphere throughout the day. No angular movements were observed which could not be ascribed to this cause, and the experiment shows that there is no annual variation greater than ½ minute of arc for any of the four stars.

Deviation in Seconds of Arc of Mean Position of each of the Four Stars. Wave-length, 1·4 m.

Period 1951	05·01 (Taurus)	12·01 (Virgo)	19·01 (Cygnus)	23·01 (Cassiopeia)
Jan.–Feb.	0±7	0±12	0±5	0±3
April–May	−27±11	+7±7	−2±2	−3±4
July	−11±6	+22±15	−5±7	−4±2

The results of the series on 1·4 m. wave-length are shown in the table. This series shows that there is probably no annual variation greater than 20 seconds of arc in the positions of 05·01 and 12·01, or 5 seconds of arc for 19·01 and 23·01. It may therefore be concluded that these four stars must be at distances greater than 1/20 parsec, and that 19·01 and 23·01 are more distant than 1/5 parsec; the absence of any detectable proper motion further suggests that they are probably at distances greater than ½ parsec.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research. Thanks are due to Mr. B. Elsmore for help with the observations, and to Mrs. A. C. Hollis

Hallett, who analysed a large proportion of the records.

F. G. Smith

Cavendish Laboratory,
Cambridge.
Sept. 28.

[1] Ryle, M., *Proc. Phys. Soc.*, A, **62**, 491 (1949).
[2] Mills, B. Y., and Thomas, A. B., *Aust. J. Sci. Res.*, A, **4**, 158 (1951).
[3] Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, **110**, 508 (1950).
[4] Ryle, M., and Hewish, A., *Mon. Not. Roy. Astro. Soc.*, **110**, 381 (1950).

Effect of a Magnetic Field on the Propagation of Sound Waves in a Ferromagnetic Material

Experiments in progress on the propagation of high-frequency longitudinal acoustic waves along a rod of ferromagnetic material have shown such waves to be influenced by the application of an external magnetic field in two ways. First, the velocity of propagation is modified, as is to be expected from the so-called ΔE effect in magnetostriction experiments, which refers to the change of Young's modulus with the applied magnetic field, and is of the order of a few per cent. Secondly, the attenuation of the waves is in general reduced as the applied field is increased, thus confirming the observations briefly noted by T. F. Rogers and S. J. Johnson[1].

In the present work, both transverse and longitudinal magnetic fields have been employed, and the effects are similar, in each case showing a decrease of attenuation towards a minimum value as the magnetization approaches saturation (see Fig. 1). μ is the attenuation coefficient defined by $\alpha = \alpha_0 \exp(-\mu x)$, where α is the pulse amplitude corresponding to the path-length x.

The experimental arrangement is essentially that shown in Fig. 2. Pulses of variable frequency and length are generated and fed to an X-cut quartz transducer, which acts as the transmitter and receiver of the sound waves, and is placed in close contact with the material under test. A film of oil is used as a coupling medium between the quartz and the material. The received signals are displayed on a cathode-ray oscillograph and typical records are shown in Fig. 3, the operating frequency being 2·5 Mc./s., and the materials refer to nickel and nickel–iron. The magnitude of the attenuation effect varies considerably with the material as indicated in Fig. 1.

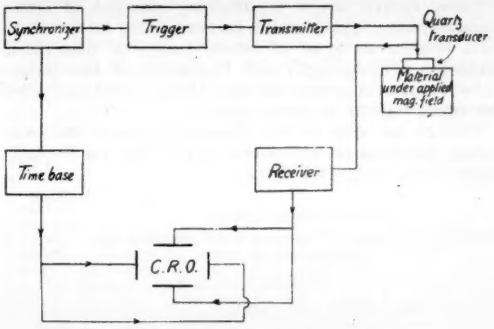


Fig. 2. Block diagram of experimental arrangement

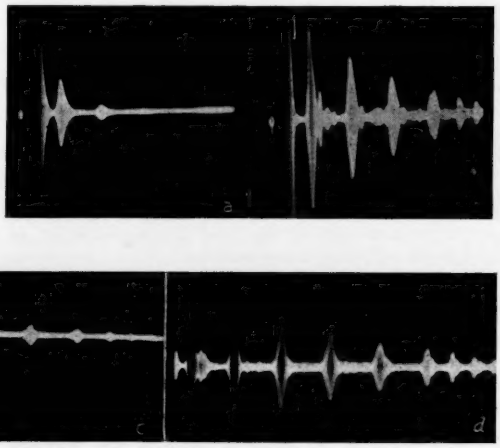


Fig. 3. Longitudinal waves in nickel-iron with: (*a*) zero applied magnetic field; (*b*) longitudinal applied magnetic field of strength 1,000 oersteds approximately. Longitudinal waves in nickel with: (*c*) zero applied magnetic field; (*d*) transverse applied magnetic field of strength 1,000 oersteds approximately

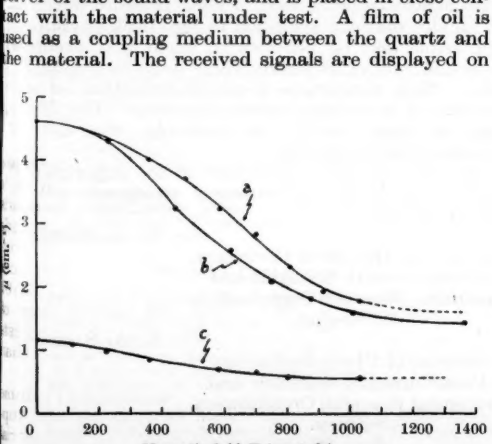


Fig. 1. Curve *a*, transverse field (nickel-iron); curve *b*, longitudinal field (nickel-iron); curve *c*, transverse field (nickel)

The curve in Fig. 4 is derived from the direct observations by plotting $(\mu_0 - \mu_H)$ against the appropriate field-strength H, and it is evident that this form of presentation shows a striking similarity to the I–H initial curves of ferromagnetic material (I being the intensity of magnetization).

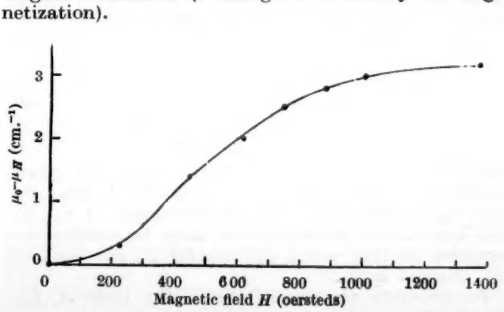


Fig. 4. Derived from Fig. 1 (*b*)

These results are a preliminary account of comprehensive investigations at present being undertaken with respect to type of wave, range of materials, magnetic field-strength and frequency of the pulse. Velocity measurements are also being correlated with the observations on attenuation.

Thanks are due to Sir George Thomson for providing facilities for this work in the Physics Department of the Imperial College.

J. de Klerk

Physics Department,
Imperial College of Science and Technology,
London, S.W.7.
July 3.

[1] *J. App. Phys.*, 21, 10, 1067 (1950).

A New Surface Viscometer

Of the methods which have been used to measure the viscosity of surface films on a liquid substrate only one, the canal or surface-slit method, is amenable to rigorous mathematical treatment. Harkins and Kirkwood[1] derived an equation which could be applied to this method provided that certain modifications could be made to the apparatus as used by Joly[2]. To measure the viscosity of dilute soluble films (to which the surface-slit method cannot be applied), a new method has been developed which is capable of rigorous interpretation.

The substrate (water or solution) is made to flow at a constant volume rate, V, through a horizontal channel of rectangular cross-section which it fills completely. The velocity, v_m, of an element of the surface along the centre of the channel may be measured by observing the passage of a floating particle of graphite between marked positions.

So long as there is no surface-pressure gradient, the flow velocity, v, satisfies, besides the Navier–Stokes equation, the boundary condition in the surface ($z = 0$):

$$\mu \partial^2 v/\partial x^2 + \eta \partial v/\partial z = 0,$$

where the distance, x, is measured across the channel and z vertically downward. For a channel of width a and depth b and a very small hydrostatic pressure gradient, A, in the direction of flow we find:

$$v_m = \frac{4Aa^3}{\pi^2} \Sigma' \sin \frac{n\pi}{2} \frac{\tanh (n\pi b/2a)}{n^3 a\eta \coth (n\pi b/a) + n^4 \pi\mu} \quad (1)$$

and

$$V = \frac{Aba^3}{12\eta} = \frac{8Aa^4}{\eta\pi^5} \Sigma' \frac{a\eta + 2n\pi\mu \tanh(n\pi b/2a)}{n^5 a\eta + n^6 \pi\mu \coth (n\pi b/2a)}, \quad (2)$$

where the sum is to be taken over all odd values of n. The ratio v_m/V is independent of A, and for $b \geqslant 3a$ simplifies to:

$$\frac{v_m}{V} = \frac{48 \Sigma' (-1)^{(n-1)/2} \frac{1}{n^3 + n^4 \pi\mu/a\eta}}{\pi^3 ab - \frac{96a^2}{\pi^3} \Sigma' \frac{1}{n^5} \frac{a\eta + 2n\pi\mu}{a\eta + n\pi\mu}} \quad (3)$$

The only unknown in this equation is μ; for given values of a, b and η, it is a simple matter to plot the ratio v_m/V against μ. The measurement of v_m, to give less than 5 per cent error, must be confined to particles floating along the central 20 per cent of the channel surface.

To illustrate the sensitivity of the method, for $a = 0{\cdot}153$ cm., $b = 0{\cdot}60$ cm., and $\eta = 0{\cdot}01$ poise, the following table shows values of v_m/V corresponding to a range of values of μ:

$\mu \times 10^4$ (surface poise)	0	0·5	1	2	5	10	20
v_m/V	17·8	16·3	15·1	13·1	9·3	6·3	3·8

An experimental difficulty occurs in measuring the surface viscosity of some surface-active solutions. A negative surface-pressure gradient is set up along the channel, tending to retard the surface flow. If a barrier is placed across the surface of the channel before commencing the bulk flow, the surface pressures at the ends of the channel may be kept the same. When the flow has reached a steady state, the barrier is lifted and measurements of v_m are made after measured intervals. The value of v_m for zero surface-pressure gradient is then obtained by extrapolation. The form of the v_m versus time curve, and the difficulty of obtaining measurements at short intervals after lifting the barrier, sometimes makes this method impracticable and recourse is being made to a second method. After a period, v_m approaches a constant value, apparently indicating that a steady state with a constant surface-pressure gradient has been set up. By making further assumptions it is possible to make allowance for this back pressure (a measurable quantity) and to calculate the surface viscosity from the steady-state flow.

It must be assumed, with Harkins and Kirkwood[1], that the surface film is incompressible, that surface viscosity is independent of surface pressure and that there is no slip between surface film and substrate. Equations for v_m and V, obtained in the same way as the Harkins and Kirkwood equation in terms of a surface-pressure drop B, may be superposed linearly on the equations (1) and (2) to give equations for the flow when both hydrostatic and surface-pressure gradients are operative. The hydrostatic pressure gradient, A, is again eliminated between these equations to obtain an equation of the form:

$$VK_1 + BK_2 - v_m K_3 = 0,$$

where K_1, K_2 and K_3 are analytical functions of μ, η, a and b. By plotting v_m/V against μ, a family of curves is obtained for various values of B/V.

Where the surface film is moderately close packed, for example, in condensed insoluble films and in concentrated soluble films, a back pressure develops so rapidly that extrapolation to zero back pressure is impossible and v_m becomes so small that accurate determination of its steady value becomes impracticable. This constitutes a major limitation on our method of measuring surface viscosity. For dilute gaseous films, soluble or insoluble, the method appears most promising.

A more complete description of the experimental methods and the mathematical treatment will be published later.

W. E. Ewers

Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.

R. A. Sack

Division of Electrotechnology,
Commonwealth Scientific and
Industrial Research Organization,
Sydney.
June 26.

[1] Harkins, W. D., and Kirkwood, J. G., *J. Chem. Phys.*, 6, 53 (1938).
[2] Joly, M., *J. Phys. et Rad.*, 8, 471 (1937).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 3

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. W. S. Feldberg, F.R.S.: "Acetylcholine and the Central Nervous System".*

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. E. Gray: "Some Aspects of Industrial Filtration".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. W. A. M. Edwards: "The Sulphuric Acid Industry—Changing Raw Materials and Processes".

SOUTH-EAST LONDON TECHNICAL COLLEGE (at Lewisham Way, London, S.E.4), at 7 p.m.—Mr. W. Stern: "The Production of Sapphire Bearings".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. C. H. Hampshire: "The International Pharmacopoeia".

Tuesday, December 4

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. Matthews, Mr. H. F. Goodman and Mr. G. H. Botham: "The Design of Process Equipment with special Hygienic Requirements".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Servicing of Electrical Instruments in Large Industrial Undertakings" (to be opened by Mr. A. J. Young); Discussion on "The Maintenance of Electrical Instruments in Atomic Energy Factories" (to be opened by Dr. Denis Taylor).

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. H. Read: "Chemical Control of Glass-house Pests and Diseases".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. L. J. Witts: "The Scientific Basis of Medicine, 17, The Rate and Materials of Blood Formation".* (Further Lectures on December 6 and 11.)

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. M. Horwood: "Industrial Microbial Enzymes".

Wednesday, December 5

JOINT COMMITTEE ON MATERIALS AND THEIR TESTING and the INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m.—Symposium on "Recent Developments in the Notch Bar Testing of Materials and their Relation to Welded Construction".

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre, Victoria and Albert Museum, South Kensington, London, S.W.7), at 3.30 p.m.—Dr. H. Ruhemann: "Great Painters' Techniques and Colour Reproduction".

ASLIB (at the British Council Film Theatre, 6 Hanover Street, London, W.1), at 5.30 p.m.—Mr. Bernard Chibnall: "Shell Film Unit Stock Shot Library".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. E. Axon: "An Investigation into the Mechanism of Magnetic-Tape Recording".

ROYAL METEOROLOGICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. J. Paton: "The Optical Properties of the Atmosphere". (Sixth-form Scholars are invited to attend.)

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "The Food Standards Issue—What does the Future Hold?".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science in the Mountains" Speakers: Dr. M. F. Perutz, Dr. E. P. George and Dr. B. H. C. Matthews, F.R.S.).

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, University College, Gower Street, London, W.C.1), at 8.15 p.m.—Prof. T. M. Newcomb: "Some Contemporary Developments in Social-psychological Research".

Thursday, December 6

UNIVERSITY OF LONDON (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Prof. J. Z. Young, F.R.S.: "The Anatomy of Learning".*

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Sixth Annual General Meeting; at 5.15 p.m.—Mr. B. Blay and Mr. K. W. Glover: "The Measurement of Flow and Level of Liquefied Gases".

BRITISH GLACIOLOGICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. F. Nye: "The Mechanics of Glacier Flow".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. L. Haslegrave: Technical Colleges and Education for the Electrical Industry".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. L. J. Witts: "The Scientific Basis of Medicine, 18, Alimentary Factors in Blood Formation".* (Further Lecture on December 11.)

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. P. B. Medawar, F.R.S.: "Some Unsolved Problems of Biology".*

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. Seddon: "Air Intakes for Gas Turbines".

COLLEGE OF PRECEPTORS (at 2 Bloomsbury Square, London, W.C.1), at 6 p.m.—Mr. Geoffrey Gorer: "The Limitations of National Thinking and Feeling" ("Horizons in the School", 1) (Joseph Payne Memorial Lectures).*

SOCIETY OF CHEMICAL INDUSTRY, BRISTOL SECTION of the CHEMICAL ENGINEERING GROUP (in the Chemical Department, The University, Woodland Road, Bristol), at 6.30 p.m.—Mr. K. Sharples and Mr. F. G. Shepstone: "Chemical Engineering Applied to the Fertilizer Industry".

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. Bryan R. Overton: "Television Receiver Design for British and European Systems—a Comparative Study".

Friday, December 7

ROYAL METEOROLOGICAL SOCIETY, SCOTTISH CENTRE (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 5.15 p.m.—Dr. R. C. Sutcliffe: "The Use of Upper-Air Contour Charts in Forecasting".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. C. H. Bradbury: "The Measurement and Interpretation of Machinery Noise with Special Reference to Oil Engines".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON GROUP of the INDUSTRIAL APPLICATIONS SECTION of the ROYAL STATISTICAL SOCIETY, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. G. E. P. Box: "The Planning of Experiments in the Chemical Industry".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. W. S. Patterson: "External Ship Corrosion due to Bacterial Action".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (joint meeting with the LOCAL SECTIONS of the CHEMICAL SOCIETY and the ROYAL INSTITUTE OF CHEMISTRY, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Sir Ben Lockspeiser, F.R.S.: "Scientific Problems in the D.S.I.R.".

Saturday, December 8

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual General Meeting; at 2.30 p.m.—Dr. Lilian E. Hawker: "The Physiology of Myxomycetes" (Lister Memorial Lecture).

BRITISH PSYCHOLOGICAL SOCIETY (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. C. A. Mace: "Education for Management in the United States—a Psychologist's Impression".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade A) IN PHYSICS AND PHYSICAL CHEMISTRY, and an ASSISTANT (Grade A) IN MECHANICAL ENGINEERING, at the Birkenhead Technical College—The Director of Education, 63 Hamilton Square, Birkenhead (December 8).

HEAD OF THE PURE AND APPLIED SCIENCE DEPARTMENT (with good academic qualifications in physical chemistry, and experience in teaching to B.Sc. and A.R.I.C. standard)—The Principal, Mining and Technical College, Church Street, Barnsley (December 8).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (December 8).

STATISTICIANS (with honours degree in mathematics and training or experience in statistics) to initiate and take charge of the Centre, under the supervision of the Honorary Director—duties will be (*a*) the collation of world data on blood groups in relation to anthropology, including their analysis, and (*b*) the anthropological analysis of blood records of Great Britain—The Hon. Director, Nuffield Blood Group Centre of the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1 (December 8).

LECTURER IN MATHEMATICAL PHYSICS—The Secretary, The University, Edgbaston, Birmingham 3 (December 10).

LECTURER IN PUBLIC HEALTH—The Secretary, The University, Aberdeen (December 10).

LECTURER IN ORAL ANATOMY AND HISTOLOGY, combined with preventive dentistry, and a DEMONSTRATOR AND RESEARCH ASSISTANT IN DENTAL AND ORAL PATHOLOGY—The Registrar, The University, Sheffield (December 15).

SCIENTIST III (with an honours degree in science, preferably in chemistry and physics, or an equivalent qualification) in the Records Section of the Scientific Department at London headquarters, to assist in the collection and interpretation of scientific data and to prepare information reports—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/399 (December 18).

METEOROLOGICAL OFFICERS (6) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 21).

CHIEF COAL SURVEY OFFICER (with high academic scientific qualifications; sound all-round knowledge of fuel technology and some research experience are desirable) in the Scottish Division—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/403 (December 22).

SITE SUPERINTENDENT, a DEPUTY SITE SUPERINTENDENT, EXPERIMENTAL OFFICERS, and ASSISTANT EXPERIMENTAL OFFICERS, by the MINISTRY OF FUEL AND POWER for experiments in underground gasification—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.862/51A (December 22).

ANIMAL HUSBANDRY OFFICER—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (December 24).

CIVIL ENGINEERS, SANITARY ENGINEERS, and STRUCTURAL ENGINEERS (all with the appropriate professional qualifications and experience) in a number of Departments in England and Wales—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405.LA (December 31).

READER IN THE DEPARTMENT OF GEOGRAPHY IN THE RESEARCH SCHOOL OF PACIFIC STUDIES—The Administrative Officer in the United Kingdom, Australian National University, 27 Russell Square, London, W.C.1 (December 31).

SENIOR LECTURER, and a LECTURER, IN CIVIL ENGINEERING, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

SENIOR LECTURER IN VETERINARY PATHOLOGY AT THE UNIVERSITY OF QUEENSLAND—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 5).

SCIENTISTS II or III (Ref. TT/400) (with honours degree in electrical engineering or physics, with good knowledge of electronic techniques) in the telecommunications and light electrical engineering fields, and ELECTRONIC ENGINEERS (Ref. TT/401) to design and construct electronic devices for research, at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (January 12).

SENIOR LECTURER IN GENERAL BACTERIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 14).

AERONAUTICAL AND MECHANICAL ENGINEERS (Principal Scientific Officer grade) in the Structures Department of the Royal Aircraft Establishment, Farnborough, for work on the design approval of aircraft structures or on the solution of airworthiness problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting C.684/51A.

ELECTRICAL ENGINEERS AND PHYSICISTS AT THE ROYAL AIRCRAFT ESTABLISHMENT, South Farnborough: PRINCIPAL SCIENTIFIC OFFICER (Ref. D.501/51A) to act as Deputy Leader of a team engaged on the research and development of novel applications of radio techniques; SENIOR SCIENTIFIC OFFICER and SCIENTIFIC OFFICER (Ref. A.345/51A) to assist in various aspects of the work detailed above; SENIOR SCIENTIFIC OFFICER (Ref. A.346/51A) to work on novel forms of sighting equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL ENGINEERS and PHYSICISTS (Scientific Officer grade) in the Instrument and Photographic Department of the Royal Aircraft Establishment, Farnborough: (Ref. A.347/51A) for the assessment of analogue computor and servomechanism techniques and the development of precision equipment in that field for use in aircraft; (Ref. A.348/51A) for the analysis of the complex dynamical problems arising in automatic control of aircraft and for research upon methods of control; (Ref. A.349/51A) for research and development work in connexion with gyroscopic and allied instruments; (Ref. A.350/51A) for the development of aircraft cameras, involving image movement compensation, exposure frequency control and gyroscopic stabilisation—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ENGINEERS by the MINISTRY OF SUPPLY in London: (Ref. C.690/51A) for the production planning of chemical and mechanical propulsion units (rocket motors, pulse jet engines, etc.), ancillary equipments (fuel and booster pumps, mixing and pressure valves, igniters, etc.); (Ref. C.691/51A) for the production planning of guidance equipment (electronic, air and ground guidance apparatus, valves, fuses, test gear) and control equipment (mainly gyroscopic and servo-mechanisms) for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

HEAD OF THE DEPARTMENT OF POWER ENGINEERING AND ELECTRICAL TECHNOLOGY, Indian Institute of Science, Bangalore, India—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.485/510A.

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

HONOURS GRADUATES IN PHYSICS or CHEMISTRY, for research work in connexion with the pottery industry—The Director of Research, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

INSPECTOR OF HORTICULTURE (with a university degree or diploma in horticulture and/or Kew certificate) in the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Horticulture 4/217'.

INSPECTORS (2) OF MINES, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27099/5/51.

JUNIOR LECTURER (with an honours degree in chemistry) to assist with the teaching work of the DEPARTMENT OF CHEMISTRY—The School Secretary, Middlesex Hospital Medical School, London, W.1.

MECHANICAL ENGINEER (with A.M.I.Mech.E. or a degree in mechanical engineering), Northern Rhodesia, to assist the Senior Mechanical Engineer in administration of the Government's Mechanical Workshop Organization—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27325/8.

PHYSICISTS and ELECTRICAL ENGINEERS (Experimental Officer grade) in the Instrument and Photographic Department of the Royal Aircraft Establishment, Farnborough, for (*a*) development work on analogue computors and servomechanisms, (*b*) development of automatic pilots and associated equipment, and (*c*) research and development work in connexion with gyroscopic and allied instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.352/51A.

PHYSICISTS and ELECTRICAL ENGINEERS (Scientific Officer grade) at a Ministry of Supply research establishment in the south-east of London: ELECTRICAL ENGINEER (Ref. D.490/51A) with a sound knowledge of physical principles and electronic applications to physics problems, a PHYSICIST or ELECTRICAL ENGINEER (Ref. A.337/51A) with experience in radio communications, a PHYSICIST (Ref. A.337/51A) with experience in electronic circuitry problems, for measurement of high-speed transients, an ELECTRICAL ENGINEER (Ref. D.490/51A) for research and development in V.H.F. and U.H.F. transmission and reception, and an ELECTRICAL ENGINEER (Ref. D.490/51A) for design and development work in a wide field of electronic instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

PRE- AND POST-DOCTORAL RESEARCH and combined research and teaching positions in the fields of Colloid, Inorganic, Organic, and Physical Chemistry—Prof. R. D. Vold, Department of Chemistry, University of Southern California, Los Angeles 7, Calif., U.S.A. (apply by air mail).

RESEARCH METALLURGISTS (graduates) for work in the Tinplate Section—The Director, Tin Research Institute, Fraser Road, Greenford, Middx.

SENIOR LECTURER IN MATHEMATICS, a SENIOR LECTURER IN CHEMISTRY, a SENIOR LECTURER IN PHYSICS, and a SENIOR LECTURER IN TELECOMMUNICATIONS ENGINEERING—The Clerk, Northern Polytechnic, Holloway, London, N.7.

SENIOR LECTURER IN PHYSICS, a LECTURER IN PHYSICS, a LECTURER IN ZOOLOGY AND PHYSIOLOGY, an ASSISTANT (Grade B) IN CHEMISTRY, and an ASSISTANT (Grade A) IN MATHEMATICS—The Principal, West Ham Municipal College, Romford Road, London, E.15.

SENIOR LECTURER, and a LECTURER, IN THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Salford 5.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER in the MECHANICAL ENGINEERING DEPARTMENT of the Royal Aircraft Establishment, Farnborough: (Ref. C.685/51A) for research into the more fundamental aspects of the development of aircraft hydraulics, pneumatics and oxygen systems involving problems of gas and liquid flow, control systems and storage, (Ref. C.686/51A) for work on research aspects of aircraft vulnerability and weapon lethality, including field trials on representative aircraft parts, studies of new aircraft and weapons and statistical analysis of test results; SENIOR EXPERIMENTAL OFFICER and EXPERIMENTAL OFFICER: (Ref. C.687/51A) to work on air crew oxygen breathing equipment which requires a knowledge of light precision engineering and a capacity for experimental and development work on components such as capsule and diaphragm operated mechanisms, reducing valves, etc.; EXPERIMENTAL OFFICER: (Ref. C.688/51A) to assist with general laboratory and flight work on light mechanisms, cabin conditioning, hydraulic and pneumatic systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

SENIOR SCIENTIFIC OFFICERS or SCIENTIFIC OFFICERS IN THE STRUCTURES DIVISION of the Royal Aircraft Establishment, Farnborough: (Ref. C.707/51A) for theoretical work on aircraft flutter as affecting aircraft design, (Ref. C.708/51A) for investigation of problems connected with the specification of basic conditions for aircraft structural design, (Ref. C.709/51A) for investigation of dynamic problems as affecting aircraft structure, (Ref. C.710/51A) to assist with the design approval of aircraft structures and aircraft structural components—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Manchester Public Libraries. 99th Report of the Libraries Committee, 1950–51. Pp. ii+41+4 plates. (Manchester: City Library, 1951.) [139

Scientific Survey of South-Eastern Scotland. Prepared for the Meeting held in Edinburgh, 8th to 15th August, 1951. Pp. 208. (Edinburgh: Local Executive of the British Association, 1951.) 15*s*. [179

Institute of Personnel Management. Annual Report 1950–51. Pp. 16. **Occasional Papers No. 1: The Personnel Aspects of Management.** By Dr. C. H. Northcott. Pp. 60. 3*s*. (London: Institute of Personnel Management, 1951.) [179

Report on the Work of the British Council for the Year ended 31st March 1951. Pp. v+120. (London: British Council, 1951.) [179

Sampling and Analysis of Tin Ingots. By Dr. J. W. Price. Pp. 6. (Greenford: Tin Research Institute, 1951.) Free. [179

Proceedings of the International Conference on Low Temperature Physics, held under the auspices of the International Union of Pure and Applied Physics, Oxford, August 22nd–28th, 1951. Edited by Dr. R. Bowers. Pp. xiii+165. (Oxford: Clarendon Laboratory, 1951.) 15*s*. [211